BOARD OF AGRICULTURE AND FISHERIES.

LEAFLETS

(Nos. 101 to 200).

SEVENTH EDITION

WITH INDEX.

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The Board of Agriculture and Fisheries issue their leaflets Nos. 1-300 in three volumes bound in stiff boards. The present volume contains the latest editions of leaflets Nos. 101-200 (omitting Nos. 106, 114, 129, 142, 167, 176, 179, 190 and 198), together with an index of their contents. The volumes can be obtained from the offices of the Board, 3, St. James's Square, London, S.W.1, each price 1s. net; or the three volumes, 2s. 6d., post free.

The leaflets are also issued singly, and may be obtained free of charge and post free on application to the Board. Letters of application need not be stamped.

Leaflets Nos. 106, 114, 129, 142, 167, 176, 179, 190 *and* 198, *are omitted from this edition, as the information contained in them is not fully applicable under present conditions. In regard to the manuring of crops, feeding of live-stock and poultry, and the manufacture of cheeses the recommendations of the Board as regularly communicated to the public by means of their Journal, Special Leaflets, Press Notices, &c., should be followed.*

London, S.W.1,

August, 1917.

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Leaflet No. 101.

BOARD OF AGRICULTURE AND FISHERIES.

Prevention of White Scour in Calves.

In order successfully to combat the disease known as White Scour in calves, a disease which yearly claims a large number of victims, the following procedure should be fully and carefully attended to :—

Disinfection of Premises.

The floors of cow-houses and calf-houses should be thoroughly cleaned and disinfected at least once each week with a solution of blue-stone (*Copper sulphate*), made by adding 2 lb. of blue-stone to 3 gallons of water. The floor of the calf-house should be of concrete, and should be swept daily and disinfected with a solution of blue-stone of the above strength.

Navel Treatment.

(*a.*) When a cow is about to calve she should be given a good bed of clean fresh straw to keep the calf clean.

(*b.*) When she shows signs of calving her "bearings" should be washed with a warm 5 per cent. (minimum) solution of carbolic acid (containing not less than 95 per cent. of actual carbolic acid) or an equivalent disinfectant in rainwater. The solution, at half strength, should also be injected into the passage through which the calf is to be born.

(*c.*) Immediately the calf is born the navel cord should be tied with twine which must be kept ready in the carbolic acid solution. The person who ties the cord should first scrub and wash his hands with the solution.

(*d.*) Immediately the cord is tied the portion adhering to the calf, as well as the surrounding part of its body, should be carefully painted with a solution of iodine in methylated spirits (35 grains of iodine to 2 pints of methylated spirits).

(*e.*) After a few minutes the navel cord should be painted with a layer of collodion containing 1 per cent. of iodine, or with Stockholm tar.

General Recommendations.

1.—Navel treatment without repeated and careful disinfection will NOT be successful.

2.—Newly-born calves should be placed in a spot which has been freshly disinfected. Carbolised sawdust will be found a useful litter.

3.—Healthy calves should not be housed or fed with those that are diseased.

4.—Separated milk should not be given until the calf is four weeks old. The change from new to separated milk should be gradual. The calf should have a substitute for the cream removed by the separator. One to two oz. per day of the best cod liver oil, or a mucilage prepared by steeping linseed or good linseed cake in hot water, will be found useful for this purpose. The quantity, however, should be carefully regulated in accordance with the state of the bowels.

For further hints on the treatment of calves reference should be made to Leaflet No. 142 on Calf Rearing.

Whitehall Place, London, S.W.1,
March, 1904.

Revised, October, 1913.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, *St. James's Square, London, S.W.*1, *Letters of application so addressed need not be stamped.*

Leaflet No. 102.

BOARD OF AGRICULTURE AND FISHERIES.

Blackquarter, Quarter Ill, or Black Leg.

Blackquarter is a bacterial disease caused by the blackquarter bacillus.

Distribution.

Although blackquarter is known to have occurred in many parts of Great Britain for a great many years, no statistics of the number of animals which become affected annually, or of the districts in which it is prevalent, are available, as the disease has not been scheduled under the Diseases of Animals Act. The disease appears to be very irregularly distributed, and even on the same farm it may occur in some fields and not in others. The danger of infection is greatest on permanent pasture, and on uncultivated land, and often disappears when the land is drained, and cultivated. Although low lying, damp land is more favourable to the disease it is also found on high land. The disease is usually prevalent in the early spring and summer, but it also occurs to a less extent at other times of the year.

Animals which contract the Disease.

Cattle and sheep are the only farm animals which become affected in Great Britain. Cases have been recorded of horses and swine dying from blackquarter, but these animals can be disregarded for all practical purposes.

In this country cattle are the principal sufferers from the disease, the mortality ranging from 2 to 20 per cent. of the total young cattle on infected farms. There are, however, certain districts in which great numbers of sheep are attacked, notably Romney Marsh, where death-rates of from 2 to 40 per cent. have occurred on certain farms in certain seasons. In the case of Romney Marsh this high mortality in sheep is probably not due to any peculiar character of the bacillus found in the locality, but to the custom of grazing sheep during the spring and summer to the exclusion of cattle.

Cattle usually become affected between the ages of 6 and 18 months. Although calves under six months are susceptible they seldom contract the disease. Cattle above two years are rarely affected, and it may be said that they become less susceptible with advancing age.

The Bacillus of Blackquarter.

The bacillus is usually rod-shaped, but it may also assume the form of a drum-stick or a racket.

As it can maintain its existence in the soil apart from a living animal body, it is called a "soil" organism. The bacillus forms spores, and in this resting stage resists great variations of temperature, and retains its activity for long periods.

Symptoms.

The period of incubation is usually about three days, but in some cases it may be five days.

In *cattle* the earlier symptoms are sometimes not characteristic, and diagnosis is difficult, but as the disease progresses distinctive symptoms appear, and in districts where it is prevalent most farmers recognise them.

In the early stages the symptoms are dullness, cessation of rumination, loss of appetite, high temperature, harsh and staring coat, trembling, and coldness of the legs, feet and horns. Later, stiffness, lameness, and arching of the back are also noticeable. On closer examination the characteristic blackquarter swelling may be observed under the skin on those parts of the body covered by thick layers of muscle, such as the upper leg, loin, buttocks, shoulder, chest or neck. The swellings also sometimes affect the tongue, throat, dewlap, genital organs or mammary glands, but are never seen below the knee or the hock, or on the tail. They are at first hot and painful, but rapidly become cold and painless, and in prolonged cases they may even become hard and parchment like. On pressing the swelling a crackling noise, due to the formation of gas by the bacilli in the tissues, is heard.

As the disease progresses more gas is produced in the swellings, respiration becomes hurried, the animal is greatly distressed, and the temperature may rise to a high point. The pulse is rapid and feeble, and tympanitis (hoven) may be present. Dung, which may be blood-stained, is passed involuntarily. Towards the end the animal usually lies motionless, the temperature rapidly falls, and death follows.

The disease usually lasts from 12 to 48 hours, but in some cases it may be prolonged for 4 to 10 days. The swelling is not apparent in every case, as it occurs in the more deeply situated muscular tissues. In the absence of the characteristic swelling, colic, or digestive disturbance may be the most apparent symptoms, or there may be lameness and stiffness.

In *sheep* the course of the disease is not so prolonged as in cattle. Death usually occurs without symptoms of ill-health being noticed. Sometimes a sheep is seen to falter, fall to the ground, and die in a few moments. In some cases, however, symptoms of the disease are displayed for a considerable time before death occurs. The affected sheep stands stiffly with feet together, back arched, champs its jaws, and breathes heavily. Diarrhœa may be present with blood-stained excreta, and a frothy blood-stained discharge from the nostrils may be seen.

Swellings on the body may occur as in cattle, but they are not so apparent.

Post Mortem Appearances.

In *cattle* the carcase is usually very distended with gases, and blood-stained froth may be discharged from the mouth, nostrils, and anus. As a rule the characteristic swelling is also present. When pressed, the swelling emits a crackling sound due to the presence of the gas, and if it is cut, a blood-stained fluid, possessing a typical rancid odour, distinct from the putrid odour given off by a decomposing carcase, exudes from the cut surface. Owing to the formation of gas the muscular tissue appears to be dark red, almost black in colour, and porous looking. The blood in the vessels clots and is generally normal in appearance. In some cases lesions are absent in the superficial muscular tissues, but they are usually to be found elsewhere in the carcase.

In *sheep* the muscular lesion is the same as in cattle, but it is not so noticeable. It may be found almost anywhere in the carcase, but is usually present in the upper parts of the limbs. On a close examination of the carcase of a sheep which has died of blackquarter it will usually be found that some part of the carcase is swollen; the fleece overlying the swollen portion pulls away easily, and the skin so exposed is of a dark purple colour. The characteristic crackling of gas is heard if the swollen part is pressed, and if the swollen part is cut into, the appearance is identical with the cattle lesion. Even in districts where blackquarter is prevalent, stockowners should always bear in mind the possibility that an animal which has died after a short illness, or has been found dead, may have died of anthrax. If an animal has shown symptoms of blackquarter during life, and the characteristic swelling distended with gas is also present after death, stockowners would be justified in forming the opinion that death was due to blackquarter, but, if these characteristic signs are not present, it is possible the animal may have died of anthrax.

Infective Material and Method of Infection.

The spores may remain active in the soil for years, but their number may be added to by material from new cases, especially if infected carcases have been cut up on the pastures. The flesh or fluid of the swellings contain highly infective material, and the same applies to the blood-stained discharges. Animals do not infect each other directly, but pick up infection from the soil either by swallowing infected food or by contaminating a wound.

Prevention.

As the spore is capable of living in the soil, the greatest care should be exercised to prevent any addition to the number of bacilli already in the soil by the careless disposal

or unnecessary cutting up of the carcase. An animal which has died from the disease should not be skinned, as the small amount received for the pelt is out of all proportion to the risk which is run of further infecting the farm.

All carcases should be properly buried or burnt, especially in the season of castrating and docking.

Several methods of inoculating young stock to protect them against the disease are in use in different parts of the world. Arloing's method consists of two injections of vaccines at an interval of ten days, and it gives the inoculated animal immunity against the disease for about one year. Unfortunately, fatal accidents may follow the operation. The deaths do not amount to much—under 1 per cent. if reckoned on a large number of animals—but, since many deaths may occur on one farm, or in the same district, this form of inoculation should not be adopted unless the losses from the disease are annually very high. A safer method of protection is to use a serum together with a dose of pure culture of the bacillus. Before adopting preventive inoculation the owner of an infected farm should consult a veterinary surgeon who can advise him whether the annual losses from the disease make it worth the attendant risks. The choice of the method of vaccination and the age at which the animals should be treated should be left to the veterinary surgeon who probably knows which method has been most successful in the district.

Treatment.

No form of medical treatment has been discovered which can be relied on to cure blackquarter. Certain remedies have been widely advertised, but they have all proved valueless. Some success has been claimed in the past for the method of treatment which consists of incising the swellings and dressing the wounds with antiseptics. This method, however, is now seldom adopted, for, if the patient recovers, as it very rarely does, a large area of tissue sloughs, and the convalescent period is in consequence long and expensive to the owner.

Whitehall Place, London, S.W.1,
February, 1904.
Rewritten, May, 1916.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 103.

BOARD OF AGRICULTURE AND FISHERIES.

The Pine Sawfly (*Lophyrus pini*).

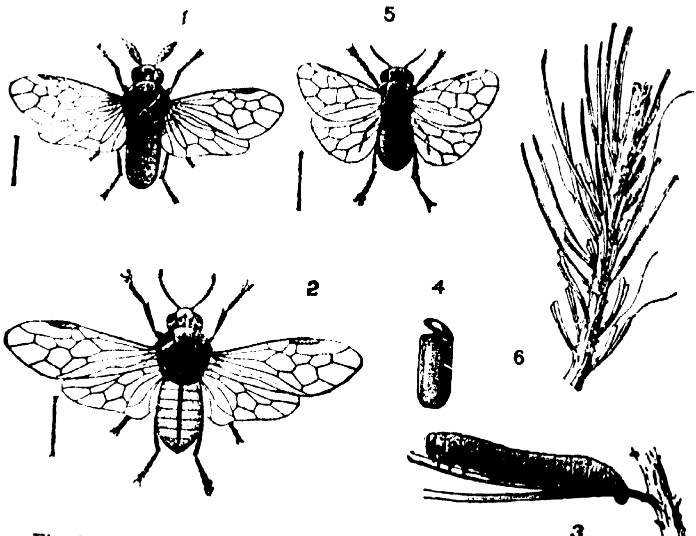

Fig. 1, *Lophyrus pini*, Male; Fig. 2, Female; Fig. 3, Larva; Fig. 4, Cocoon; Fig. 5, *Lophyrus rufus*; Fig. 6, Pine shoot attacked by Sawfly larvæ. Lines show natural size of Figs. 1, 2, and 5.

Young Pine trees, especially the Scots Pine and Black Austrian Pine, are frequently seriously damaged by the larvæ of sawflies. The chief culprit is the Pine Sawfly (*Lophyrus pini*), but *Lophyrus rufus* may, in Pine plantations, be very destructive.

The Pine Sawfly prefers trees with a sunny aspect, and hence it will be noticed in greatest abundance at the borders of plantations or around clearings. Trees from ten to thirty years old are subject to the ravages of this pest, but younger and older trees may sometimes be seen severely attacked. The damage they do is soon noticeable owing to the larvæ feeding in companies; these colonies number sometimes as many as a hundred individuals, but

as the larvæ grow they disperse. The harm done is two-fold; the needles are eaten, and the bark of the shoots bearing these needles is also gnawed away. The young caterpillars eat the needles from the side, the midrib being left hanging. Older caterpillars eat the complete needles right down, or almost right down, to the dwarf shoot. Another sign of attack is the characteristic greenish excrement lying below the food plant. There may be two broods during the year.

This forest pest often attacks large areas at the same time. In one instance 2,000 acres were invaded. The caterpillars are not hardy, and may disappear suddenly, as they are susceptible to climatic changes, cold and wet weather being very prejudicial to them.

Description.

The adult L. pini is nearly three-fifths of an inch across the wings in the male (Fig. 1), and about four-fifths in the female (Fig. 2). The male is black, with the apex of the abdomen reddish; and with white spots on the underside of the first segment; in the female the body is dull yellow, with three dark areas on the thorax, and the middle of the abdomen black; the legs are yellow and the wings have dusky borders, which are, however, not so noticeable in the fore wings of the male. The sexes can most easily be distinguished by the male having doubly pectinate antennæ, those of the female being bristle-like.

The *larvæ* are nearly an inch long when full fed, and, like all the larvæ of this genus, they have twenty-two legs. They are at first pale green, almost whitish beneath, and with black sucker feet, but as they mature they become dull brownish-green with dusky marks above the prolegs, and with a dark brown head; the sucker feet are yellow with a brown line at the base.

The *cocoons* are very variable in colour, some being quite dark, others dull brownish-grey; they are about a quarter of an inch long, rounded at the ends, and hard and compact.

Life History.

The *adult sawflies* may appear at the end of April or in May and the beginning of June. The female is sluggish and seldom flies. She lays her eggs in the needles in slits cut by the saw-like processes common to the sawflies. As many as ten to twenty may be placed on each needle, but a smaller number is common. The eggs are usually laid in close proximity, each one being covered over with a resinous secretion and so protected from various enemies.

The *larvæ* hatch in from two to three weeks, appearing at the end of May and in June. They are full-fed by or in July when pupation may take place, a second generation of

sawflies issuing in July and the beginning of August. The eggs from these hatch out caterpillars which feed on until the autumn, when they make a cocoon under cover of which they lie until the next spring, when pupation takes place—the adults issuing in April or May. Or there may be only one generation in the year, the caterpillars full-grown in July lying sheltered in their cocoons until the following spring, when they pupate.

There is much overlapping however among individuals of different broods, and even of the same brood. Some caterpillars taken in August made cocoons from August 14–17, and the first adults issued on April 27th. The cocoons of those which spin up in summer are attached to bark and needles; the winter cocoons are in the soil.

The adult issues by an opening with a lid at one end of the cocoon (Fig. 4).

The Fox-Coloured Sawfly (*Lophyrus rufus*).

The male is glossy black, with the first abdominal ring and the feet (except the claws) red. The larger female is reddish-brown in colour, with black spots on the thorax, and yellow to reddish-brown legs.

It occurs on the wing in August and September. One brood only appears to exist, and is found in larval form from the end of May until the middle or end of June. The larva has a black head and is dusky greenish-grey in colour; a pale line runs along the back, and a dusky line with a pale one on each side of it above and below; the spiracles are placed on the lower pale line. The sucker feet and under side of the body are pale green. When full grown the larvæ are rather more than half an inch in length, and then form oval, pale yellowish-brown, parchment-like cocoons, both amongst the needles and amongst heather, and in the earth, &c., beneath the trees. Like the common Pine Sawfly the caterpillars also are met with in colonies, two individuals usually sitting on each needle. They pupate in June, some specimens kept under observation going into this stage in the third week in June. Although needles and other "cover" lay on the ground in the breeding cage, they pupated in the earth just as described by Kollar. The females which come from such cocoons lay their eggs in August and September in the needles as is done by *L. pini*. Other caterpillars fed in captivity made their cocoons in July. The first adults issued from these on August 24th, and adults continued to issue during the first half of September. Apparently the eggs remain in the needles all the winter and hatch out in early May.

Preventive and Remedial Measures.

(1.)—It does not appear certain that sickly trees are more attacked than healthy ones, but in any case attention should

be given to maintaining plantations in robust growth. All the Pine Sawflies have many enemies. Amongst these may be mentioned the cuckoo, goat-sucker, and starling, which devour numbers of the larvæ and adults. Numerous Ichneumon flies also prey upon them.

(2.)—When young trees are invaded, the larvæ may be easily destroyed by crushing them with a gloved hand. This should be attempted in the early stage of an attack, as at that time the larvæ are present in fairly compact groups, and are readily dealt with.

(3.)—Shaking the larvæ from the trees on to cloths spread on the ground is recommended, but is a less satisfactory method of destruction than the other.

(4.)—Another plan is to place fresh pine boughs beneath the trees and then jar the larvæ off. All those that fall to the ground collect on the boughs strewn about, and can then easily be burnt.

(5.)—Trees that have been attacked may have the ground around their trunks examined in winter, when the dead leaves, moss, etc., containing the cocoons may be raked together and destroyed.

(6.)—Ornamental trees in parks and gardens may be speedily cleared by spraying with hellebore wash or arsenate of lead.

Whitehall Place, London, S.W.1,
March, 1904.

Revised, June, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 104.

BOARD OF AGRICULTURE AND FISHERIES.

Aphides or Plant-Lice.*

Nearly all plants, both in garden and field, and under glass, suffer from the ravages of Aphides. These universal pests are most common in temperate climates, but even in the tropics whole crops are ruined by them. Aphides are known by a variety of common names, such as Plant-Lice, Green or Black Fly, Smotherers, and Dolphins, while the disease they cause is sometimes termed "Blight."

Aphides are soft-skinned insects with antennæ generally longer than the body. When wings are present they are delicate, and have few veins. On the upper surface of the abdomen two tubes are generally present—sometimes short, sometimes long—from which a liquid can be discharged. The mouth parts are fitted for piercing and sucking; the plant tissues are first pierced and then the sap is drawn away. The skin of plant-lice is provided with glands which secrete a waxy or mealy substance or woolly masses which have the power of throwing off water.

The young differ little in form from the full-grown insects and their feeding habits are the same.

Development from the young stage to adult takes a very short time, and hence multiplication of individuals is rapid. Dry, hot weather is specially favourable for Aphides.

The summer generations of Aphides are produced without the presence of males, and the females may be wingless or winged, both conditions being found in the same life-history. The winged generations spread the infestation. These females—wingless and winged alike—can give rise to live young, and this power of viviparous multiplication and the appearance of winged forms are to be associated with abundance of food at certain times of the year. As the cold part of the year comes, males as well as females are produced and fertilised eggs are laid.

Some Aphides confine themselves to one species of plant; others migrate so that part of the life-cycle is spent on a plant of a different species. Migration of the same kind of Aphid may take place to a number of quite unrelated species of plants.

Aphides damage plants in two ways; (1) by sucking away the sap and so weakening the plant, and (2) by their excrement falling on the leaves and clogging the stomata and so interfering with gaseous interchange. Further, the excrement, consisting partly of a sweet gummy substance called "honeydew," is a favourable germinating medium for the spores of some fungi, and spoiled sooty-coloured patches show on twig, leaf, and fruit.

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* The following species of Aphis are dealt with separately, viz.: Woolly Aphis (Leaflet 34), Currant Aphides (Leaflet 68), and Hop Aphis (Leaflet 88).

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Natural Checks.—Several insects prey upon Aphides, and should be encouraged. The chief of these are Ladybirds and their larvæ (*Coccinellidæ*); Hover-fly larvæ (*Syrphidæ*); and the larvæ of the Lace-wing Flies (*Chrysopidæ*). Various minute Hymenopterous parasites (*Chalcididæ*) lay their eggs in the bodies of Aphides, those parasitised being destroyed. Man cannot, however, rely solely on the services of these beneficial insects, but should check the increase of the Aphides by washes as soon as they appear upon his plants.

THE BEAN APHIS (*Aphis rumicis*, Linn.).

The Bean Aphis, known variously as Black Fly, Collier, and Black Dolphin, is in some years a very severe enemy of the bean crop, shoots and pods being quite smothered with the insects. Harm results not only from the weakening of the plant by the draining away of the sap, but also from the masses of excrement which cover and clog the outside of the plant. Important points in the biology of this Aphis are: (1) It does not confine itself to the bean crop, but is found on many other plants in widely separated Natural Orders, examples being docks, thistles, furze; (2) There are regular migrations to these plants and back to the bean again; and (3) Various generations with somewhat dissimilar individuals are found at different stages in the life-history. The following are recognisable:—(*a*) The early wingless female, on the bean, black in colour with ochreous tints on the shanks and the middle joints of the antennæ. This female produces live young; the young are slate-grey to black. At certain times a stage is found when the insects show dusky wing-cases or wing rudiments, and the abdomen is black, with white spots; this is the stage preceding (*b*) the winged females. These winged females are black or black with a brownish tinge; the shanks and middle joints of the antennæ are yellowish; the wings are yellow at the base, greenish in front, and have brown veins. These females produce live young. (*c*) Wingless females found in autumn and resembling the females of (*a*); the females of (*c*) lay eggs. (*d*) Males, appearing late in the season; they have wings, and are black or black-brown in colour.

Life-History.—The wingless females of the early part of the year are found on the bean tops, and give rise to live young. Multiplication is rapid, and ultimately winged females appear which spread the infestation to other beans and to different food plants. In the autumn, with the appearance of the males and egg-laying females, fertilised eggs are laid on the plants to which the Aphides have migrated.

Treatment.—(1) The infested tops should be cut off and burnt. This should be done early. (2) The beans should be sprayed with soft-soap and quassia. Dissolve 5 lb. of soft-soap in 100 gallons of soft water; boil 6 to 8 lb. of quassia chips in water, and add the extract to the 100 gallons of wash

THE CABBAGE APHIS (*Aphis brassicæ*, Linn.).

In the case of this species, infested leaves drained of their sap become yellow and bleached. Blistered patches shew, and under these the Aphides are found. As the numbers increase the pests are found both on the upper and lower surfaces of the leaves.

The wingless viviparous females have their bodies covered with a mealy secretion that gives them a white appearance and masks the grey-green colour of the body; dark spots are present on the upper surface; the antennæ are green or yellow-green with dark tips; legs and eyes are dark-brown or brown-black; the cornicles or tubes on the back are short and dark-brown; the young, until the mealy secretion appears, are bright yellow or yellow-green.

When the mealy secretion is removed the winged viviparous females are seen to have the front part of the body black, and the hind part yellow-green; legs and cornicles are dark-brown.

The males are green with black antennæ, and the cornicles are dark at the base.

The egg-laying female is green, with rows of dark spots on the back; the eggs are green at first, but later are black.

Life-History.—Young Aphides hatch from eggs laid in the previous autumn on cruciferous plants (both wild and cultivated). During the summer the wingless and winged virgin females are found. The winged females spread the infection. Both the wingless and the winged females produce live young. Towards the end of the season, when infestation is worst, males and wingless egg-laying females pair, and fertilised eggs are laid from which in the next year come the individuals which start the colonies for the year.

Treatment.—(1) Cruciferous weeds should be kept down as far as possible. (2) The insects should be attacked early with soap and water, and the watering should be repeated.

On large areas, as in field cultivation, no treatment will avail when widespread attack has been neglected.

ROSE APHIDES.

Different species of the genus *Siphonophora* are found on roses. One of these, *S. rosæ*, migrates to teasel and returns later in the year.

Treatment.—Spraying should be done with the soft-soap and quassia spray (p. 2), but only 4 lb. of soap should be used. Spraying should be carried out twice in the same week.

THE PLUM APHIS (*Aphis pruni*, Reaumur).

The Plum Aphis is a serious pest on plum, damson, and allied Rosaceous fruit trees. The loss of sap due to its feeding causes the leaves to curl and discolour, and the young fruits fall off.

The eggs found in autumn and winter are shining black. The young from the eggs are green or dark green; they develop into wingless viviparous females, which vary in colour from green to olive-brown. The pupal stage or stage preceding the winged viviparous female is characterised by rudiments of wings or wing-cases; the body is green and the wing-parts brownish. The winged viviparous female is apple-green, with the antennæ, head, upper surface of thorax, and the feet, black.

Of the sexual individuals, the males are small; they have wings and are yellow-brown or black in colour; egg-laying females are small and wingless; they are greenish-yellow in colour and transparent.

Life History.—Fertilized eggs are laid in the autumn on the twigs and at the base of the buds. The winter is passed in the egg stage. Hatching takes place in spring, the young from the eggs developing into adult females, which are wingless and give rise to live young. These in turn become adult wingless viviparous females. As the season advances some of the young, instead of developing as stated, show wing rudiments and develop into winged viviparous females. These may spread the infection. Late in the year males and wingless egg-laying females are found and fertilized eggs are laid, which remain unhatched over the winter.

Treatment.—(1) Spraying should take place with soft-soap and quassia wash, or with paraffin emulsion, early in the year, when the young Aphides are noticed to have hatched out. The spray should always be applied before the leaves have curled. (2) Spraying should also be done in the autumn with paraffin emulsion, in order to kill the egg-laying females, *e.g.*, late in September or during October. (3) Theobald writes favourably of a late winter wash, where the pest is abundant, the plums and damsons to be heavily sprayed with lime-wash, salt, and water-glass *just before* the bursting of the buds. This wash is said to prevent the hatching of eggs; the formula given is 1 cwt. lime, 30 lb. salt, and 5 lb. water-glass to 100 gallons of water.

Another Aphid found on plums and allied fruit plants is *Hyalopterus pruni*, Fab. As a spray against this Aphid, which is found on the under surface of the leaves, Theobald quotes a correspondent's treatment as very satisfactory, viz., paraffin emulsion, with 1 lb. of liver of sulphur added for every 100 gallons of the wash.

A third Aphid which in certain stages of its life-history is found on the genus *Prunus* is *Phorodon humuli*, described in Leaflet 88. This species is distinguished from the others by two marked projections from the forehead, between the antennæ.

Whitehall Place, London, S.W.1,
June, 1904.
Re-written, January, 1911.

Leaflet No. 105.

BOARD OF AGRICULTURE AND FISHERIES.

Wart Disease (Black Scab) of Potatoes.

(*Synchytrium endobioticum.* Percival.)

External Appearance.

The disease described in this leaflet is popularly known as Wart Disease of Potatoes, Black Scab or Cauliflower Disease, the latter name being given owing to the characteristic outgrowth which bears some resemblance to the head of a cauliflower, and not because the disease attacks that plant. In some places it is called Potato Canker, or "Fungus," while in recent years a variety of other names such as Black Wart and Potato Wart have been given to it. The name Black Scab, under which it was at one time often best known, is not well chosen, since the symptoms bear no resemblance to those of any of the diseases which pass under the name of "scab," and in the earlier stages the affected potatoes do not lose their natural colour. In advanced stages the haulm and tubers rot and assume the dark colour usually found in decaying plants, while a dark brown liquid oozes from the putrid remains.

On the other hand, in the early stages of the disease, when it is most commonly seen, the small swellings which appear in the eyes of affected tubers bear a distinct resemblance to warts, though, in the later stages or when the attack is very severe, several warts run together and form an irregular spongy mass such as is shown in the illustrations.

This outgrowth, however, is not confined to the tubers. It is frequently found at the collar of the haulm either just below or just above the ground, and in some cases distorts the leaves growing either on the stem near the collar or at the end of the underground stem, the tips of which rise above the surface. (*See* Fig. 1.) It does not follow that all the tubers on a diseased plant are affected. As a rule those which lie nearest the surface suffer the most severely, and it has been noted that late formed tubers sometimes escape infection altogether. Every stage of attack may be found on a single plant.

The vigour of the haulm is not affected in the early stages, and it has been observed that diseased plants frequently grow larger and bear larger and greener leaves. The leaves may also remain green longer than those of unaffected plants. Owing to this fact diseased plants can sometimes be distinguished at a distance from healthy plants growing in the same field.

The intensity of the disease varies somewhat with the season. In certain localities with a light, dry soil the disease

in dry seasons has been noted to be almost absent. The soil, however, remains infected, and if a wet season follows Wart Disease appears again as badly as ever.

Except in its very early stages, when it can only be discovered with the aid of a microscope, the disease can easily be detected, and can hardly be confused with any other potato disease. The similar warty outgrowth which appears in Hollyhocks, Loganberries and some other plants is not due to Wart Disease, but to a disease known as Crown Gall (*see* Leaflet No. 245), and is probably brought about by the presence of a bacterium. The disease known as Finger-and-Toe (*see* Leaflet No. 77), which attacks turnips and other cruciferous plants and produces an appearance somewhat similar to Wart Disease, is due to a microscopic organism, *Plasmodiophora brassicæ*, Wor.

Life History of the Fungus.

In its earliest stages the fungus which causes Wart Disease exists in the cells of the potato as minute masses of living matter, without any of the mycelium usually associated in the popular mind with a fungus. The parasite lives in the cells just beneath the skin, and stimulates these to active sub-division, and thus to the production of warts. During the growing season the disease is said to be spread by means of summer spores, from which numerous motile *zoospores* escape and penetrate still healthy potato tissue. Later on, this stage is replaced by a winter or resting stage. The resting-spores are encased in a hard, resistant wall, and, on decay of the diseased tubers, pass into the soil and may remain there, in that form or in some other stage not yet discovered, with undiminished vitality for many years. On germination the resting-spores are known to give rise to numerous actively motile *zoospores*, similar to those arising from the summer spores, and these infect fresh potato tubers and so spread the disease to succeeding crops.

The exact length of time that the resting spores remain alive is not known. In a dried state they probably lose their vitality sooner than if left in the ground. In the soil the fungus is known to live for two or three years, and several well-authenticated cases have occurred in which the disease has re-appeared after an interval of six years.

Spread of Disease.

Although the disease is extremely persistent when once established in the soil, and is capable of renewed activity even after the lapse of many years, it spreads very slowly and only by five direct methods.

(1) The spores of the fungus may be carried through the soil by the natural drainage of the water. The progress under these conditions is extremely slow.

Experiments carried on two years in succession and by different tests gave the same result, viz., that the normal rate of progress on level ground is nine inches a year. On a slope the progress may be as much as 28 inches, but always on the *lower side. Infection does not travel uphill.*

This result is supported by the fact that, even in some of the most seriously infected districts in England, one spot may be incapable of producing healthy potatoes except those of the immune varieties, while another spot a few yards away, not separated by any natural obstacle, may be quite uninfected.

(2) Disease may be spread by infected potatoes or haulms. It is in this way that a great deal of the disease at present in England and Wales has been brought about. Growers have, of course, very seldom, if ever, deliberately planted potatoes visibly diseased. Instead of burning diseased haulms and tubers, careless growers, however, have frequently thrown them into a corner to rot, or even on to adjoining allotments or gardens, where they have infected the soil. Several cases of disease have been definitely traced to this practice. It is now compulsory in England and Wales, under a penalty of ten pounds, to burn all haulms and roots of diseased plants, and all infected tubers, unless they are thoroughly boiled, must also be burned. Either process destroys the spores. A few cases have, however, occurred in which seed tubers, apparently sound when planted, have yielded a diseased crop. This suggests that late formed potatoes, which, being smaller, are those generally selected for seed, may contain spores of the fungus without showing any external signs of disease. Growers, therefore, should be careful not to buy seed potatoes of susceptible varieties except from districts in which disease is known not to exist. The Board are prepared to inform applicants whether any given district is free or not.

(3) Many growers have been in the habit of throwing diseased potatoes and the peelings of diseased potatoes on the dung hill, or of feeding them unboiled to pigs or other live stock. In the latter case the spores pass through the animal's body uninjured, and if the manure is applied to the potato patch infection is conveyed directly to the plant in a manner very favourable to the spread of disease. As already stated this procedure is punishable by a fine.

(4) Disease may be carried on the boots of persons walking over infected soil, or on the wheels of carts passing over infected fields. It might also be conveyed in the earth clinging to spades or other implements.

(5) Disease might be carried by birds or other animals feeding on land from which a diseased crop has been lifted.

These instances illustrate all the known ways of spreading the disease. It is obvious that since the spores are inside the potato or in the soil, disease cannot be spread by the wind, as in the case of the common potato disease (*Phytophthora infestans*), though it is possible that, on very light land, soil containing spores may occasionally be lifted and transported in the form of dust by a high wind.

Distribution of the Disease in England and Wales.

Although Wart Disease did not attract much attention until within recent years, it has now gained world-wide notoriety on account of the restrictions imposed on the exportation of English potatoes to foreign countries and to British Dominions. The first scientific description appearing in English was published by Professor Potter of the Armstrong College, Newcastle-upon-Tyne, in the *Journal of the Board of Agriculture* for December, 1902. It was there identified with a potato disease described by Schilbersky in Hungary. It was afterwards investigated by Professor Percival of the University College, Reading, who suggested that it should properly be called *Synchytrium endobioticum*, instead of *Chrysophlyctis endobiotica*, the name given by Schilbersky. It has since been investigated by many scientific writers, who have worked out the life history of the fungus more completely. Many investigations and experiments have also been made by the Board of Agriculture and Fisheries, while Mr. Malthouse of the Harper Adams Agricultural College, Newport, Salop, has made a special study of the subject and contributed much to our knowledge of the disease and of the varieties of potatoes which are found to be immune to it.

In spite of the fact that the disease was not described in England till 1902, there is no doubt whatever that it was common in many places for at least fifteen years before that date, and probably for much longer. In one district—where the disease has since almost entirely disappeared—the Board's officers have been assured it was known fifty years ago, and there is abundant evidence that most of the districts now badly affected have been attacked since the childhood of the present generation. There are, however, many counties, including some of those which are largely devoted to potato growing, in which the disease has never appeared.

It is a peculiarity of Wart Disease that it is almost entirely confined to the industrial districts of England and Wales. It is known to exist in its greatest intensity in the neighbourhood of Manchester and Birmingham, and is common in the mining towns and villages of South Lancashire, Staffordshire, Glamorgan, Derbyshire, and West Nottinghamshire.

Fig. 1.

Fig. 2.

Fig. 3.

WART DISEASE OF POTATOES.

Fig. 1. Affected stem. Fig. 2. Tuber slightly attacked. Fig. 3. Tuber badly attacked.

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It is also found in the manufacturing districts of Cheshire. North Worcestershire and the West Riding of Yorkshire, among the quarries of Cumberland, Carnarvonshire and Leicestershire, and in a few spots on the outskirts of London, Bristol, Swindon, Lincoln and other important manufacturing towns. The number of cases in the purely agricultural districts, however, is very small.

Even in the part of the country where the disease is most

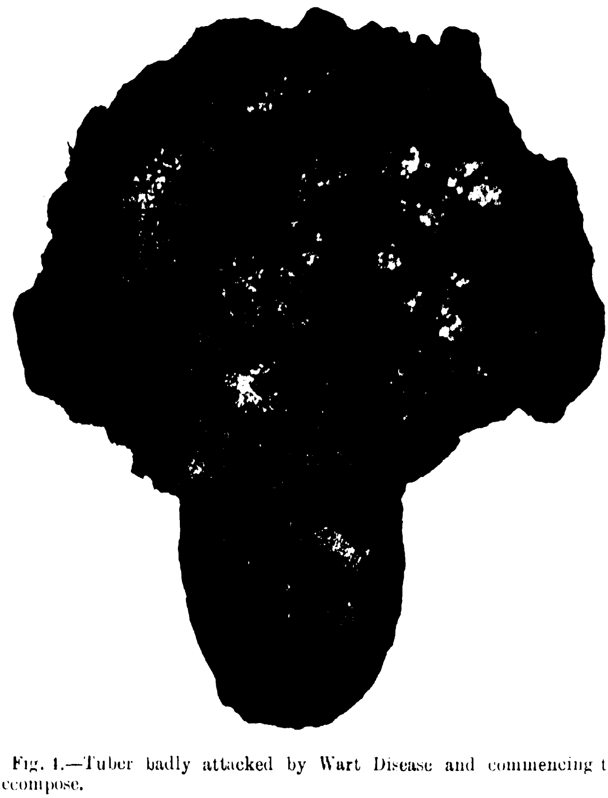


Fig. 1.—Tuber badly attacked by Wart Disease and commencing to decompose.

prevalent, viz., the area lying between Carlisle and Birmingham, the number of farms infected is still comparatively small. In a few badly affected districts there are some farms on which the potato plants, unless they are of the immune varieties, are usually diseased, but these farms have been for many years past cropped either with potatoes continuously or on a very short rotation. Outside the districts in question disease exists on a certain number of farms, but the infection is generally confined to such parts of fields as the spots where the pits were made or

the neighbourhood of the road. Throughout the greater part of the districts in which most disease occurs, the farms on which a long rotation is generally practised are free from disease, although the allotments and cottage gardens are more or less badly infected. But in a large part of the area in which Wart Disease is found the allotments and small gardens are only slightly and occasionally affected. The reports of the inspectors employed on the work, show conclusively that the disease is centred in very few places, and that round these centres are zones of decreasing intensity.

Remedial Measures.

The only successful method at present known of keeping the disease in check is by restricting cultivation to varieties which resist the attacks of the fungus. A selection of the best of these varieties is given below.

Many experiments have been made with fungicides of all kinds. Lime and sulphur, either separately or mixed in various proportions, have been tried. Soot, sulphate of copper, formalin, potassium permanganate, copper arsenate, ammonium sulpho-cyanide, calcium hypochlorite, copper nitrate and many other fungicides have also been tried. But in no case did they meet with any success when the soil was seriously infected.

Deep cultivation has been tried. The ground has been dug three spits deep, the top layer being placed at the bottom, and covered by the other layers. It was unsuccessful in preventing disease.

Until quite recently Wart Disease was only known to attack the potato itself, but it has now been found to be capable of infecting also, though apparently only to a very small extent, the Woody Nightshade (*Solanum dulcamara*) and the Black Nightshade (*S. nigrum*). This fact should be borne in mind when attempts are being made to clear the ground of the Wart Disease fungus, and any specimens of these two weeds should be uprooted and burned. There is no record at present of any other Solanaceous plants being attacked by the fungus.

Resistant Varieties.

The trials carried out at Ormskirk by the Board of Agriculture and Fisheries during the past three years demonstrate beyond all doubt the absolute immunity, for the present at any rate, of certain varieties. Disappointment in the past as to resistant varieties has been due either to (*a*) wrongly named seed, or (*b*) to the presence of "rogues," or (*c*) to the use of varieties which, though formerly supposed to be immune, had not been properly tested on badly and uniformly infected soil. As far as is known the immunity of no variety which has been thoroughly tested has as yet broken down.

The following is a selection of some of the best immune varieties recommended by the Board of Agriculture and Fisheries for planting on infected land. A fuller list, with descriptions and notes as to culture, can be obtained gratis and post free on application to the Board, Whitehall Place, London, S.W. It should be remembered that every year new varieties are tested by the Board, and that the list is subject to revision.

Early Varieties.—Conquest, King George, Great Scot.

Late Varieties.—Abundance, Admiral, Langworthy, St. Malo Kidney.

There are several variations of these types, details as to which are given in the Board's Annual List.

Wart Disease Order.

Wart Disease of Potatoes (*Synchytrium endobioticum*) has been scheduled as a notifiable disease under the Destructive Insects and Pests Acts, 1877 to 1907, and all occupiers of land on which the disease occurs must at once report its appearance to the Board, or to one of the persons appointed by the Board to receive reports. In reporting an outbreak occupiers must state their names in full and their postal address and, where possible, a specimen for identification should accompany the letter.

It is also illegal to use for planting any diseased tubers, or to sell for planting potatoes grown on any infected premises without a licence from the Board. The sale of visibly diseased tubers is also an offence under the Wart Disease of Potatoes Order, 1914.

No occupier of land which has been scheduled as "infected premises," and no occupier of land situated within an area which has been scheduled as an "infected area," may plant potatoes on such land without a licence obtained from the Board of Agriculture and Fisheries.

No charge is made for this licence, but as a rule no licence will be issued unless the applicant specifies one or more of the varieties quoted in the Board's list, and gives the name of some dealer who can satisfy the Board that the potatoes will be true to type and free from rogues. A list of such dealers can be obtained from the Board on application.

Any contravention of the orders dealing with this disease renders the person offending liable on conviction to a penalty not exceeding Ten Pounds.

Whitehall Place, London, S.W.1,
April, 1904.

Revised, December, 1916.

Copies of this leaflet may be obtained free of charge and post free on application to the Board of Agriculture and Fisheries, 3, *St. James's Square, London, S.W.*1. ***Letters of application so addressed need not be stamped.***

Leaflet No. 106.

BOARD OF AGRICULTURE AND FISHERIES.

Fertilisers for Market Garden Crops.

This Leaflet has been temporarily withdrawn:
See statement in Prefatory Note.

Leaflet No. 107.

BOARD OF AGRICULTURE AND FISHERIES.

The Mussel Scale (*Mytilaspis pomorum*, Bouché).

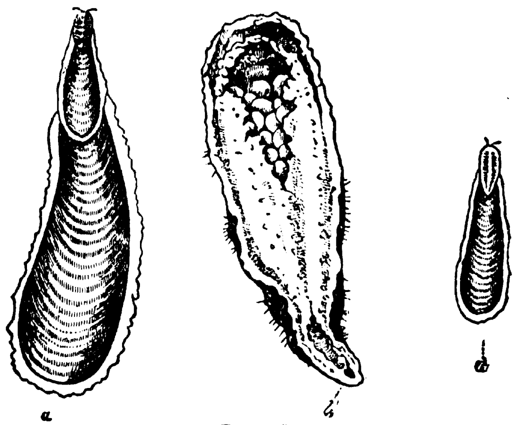


FIG. 1.*

a. Female Mussel Scale, dorsal view; *b.* The same, ventral view; *c.* Male scale.

The Mussel Scale is found chiefly on apple, but also on pear, currant, plum, and hawthorn. It has also been found abundantly on blackthorn in Devonshire. This pest, one of the most injurious scale insects existing in Great Britain, is found in North America, and also in Australia, New Zealand, and South Africa, where it has been imported on nursery stock. In this way it is also largely distributed in this country. Old trees and neglected orchards chiefly encourage the scale, but young stock suffer from its effects far more than old.

The scale insect damages the trees by sucking out the sap by means of a long, flexible mouth which it inserts into the plant tissues. It occurs not only on the trunk and boughs, but also on the leaf and fruit; it may frequently be found on imported apples.

Description.

This "scale" is frequently taken for growths on the bark, but it is the product of a minute insect belonging to

* From "First Report on Economic Zoology" (F. V. Theobald), British Museum (Natural History).

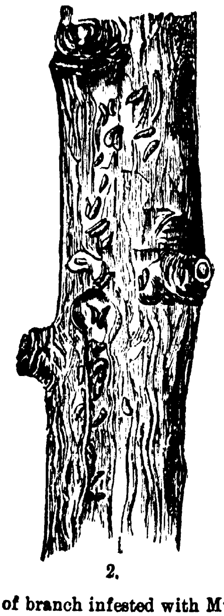
the *Coccidæ*. The male and female insects differ in appearance and size, but the males are seldom observed.

Mature Scale.—The *female* scale (Fig. 1, *a* and *b*) is about one-eighth of an inch long, rounded behind, but tapering to a point at the head end. It may be straight or curved, and even much contorted. In colour it varies from deep brown to a colour approaching grey. The female scale insect is fleshy, legless, and provided with a long flexible proboscis. The *male* scale is much smaller than the female, and of the form shown in Fig. 1, *c*. The male scale insect is very different in appearance to the female, and is provided with two rather larger wings.

The Larva.—The larva is very small, active, and six-legged. It is about one-hundredth of an inch long.

The Egg.—To the naked eye the eggs resemble small whitish dust.

The Scale.—As in all *Coccidæ*, the scale is a product formed by the insect which lives beneath it, partly by excretions from its body, and partly by the cast skins of the insect, the so-called *exuviæ*.



2.

FIG. 2.—Piece of branch infested with Mussel Scale.

Life-History.

The eggs are laid by the sedentary female under the scale. As many as 80 may be counted under a single scale, but the number varies considerably. The eggs give rise in the early

summer to the six-legged larvæ, which crawl from beneath the scales, and may be distributed from tree to tree by the wind, by birds, and by predaceous insects, such as lady-birds. In a few days they fix themselves to the plant by their short proboscis and draw away the sap ; the scale then commences to form by the excretion of a few waxy threads, and gradually grows to the form shown in figure 2. During this period the larva loses its legs and becomes converted into a fleshy legless creature ; the female remains feeding beneath the scale, with her proboscis inserted into the tissues of the plant. Towards the end of the summer she deposits her eggs and dies, her shrivelled skin remaining beneath the scale.

If the larva is to become a male, not only is a different scale produced (most often upon the leaves), but a totally different mature insect. The male undergoes a kind of pupal stage, and escapes from the scale as a small winged insect. The males are very rare, most of the females reproducing asexually. A single annual brood is the normal condition of things in Great Britain.

Treatment.

1.—The trunks, &c., of all trees should be kept clean, *i.e.*, free from rough bark, moss, and lichens. This can be done by washing in winter with the Woburn Wash recommended in Leaflet No. 70 (*The Treatment of Neglected Orchards*). It may be given as follows :—

Paraffin	2 gallons.
Soft Soap	$1\frac{1}{2}$ lb.
Caustic Soda ...	6 lb.
Water	28 gallons.

In order to prepare the wash the soft soap should be dissolved in a gallon of boiling water ; the paraffin should then be added, and the mixture churned thoroughly until a cream-like mass results. The thoroughness of the churning is important. (This paraffin-emulsion, if well made, will keep good for a long time.) The caustic soda should next be dissolved in the remaining 27 gallons of water and then poured into the paraffin-emulsion. The whole should be well mixed and used immediately. This wash has the advantage of destroying both scales and eggs.

2.—In cases of bad infestation a certain number of scales and eggs will be likely to escape the treatment, and hence a spray of paraffin-emulsion should be applied about the middle of June. This would account for the young scales not long hatched.

3.—Fumigation with hydrocyanic acid gas (*see* Leaflet No. 188) has proved a valuable scale remedy. There is no doubt that such fumigation is effective against the mussel scale in its active stages, but unfortunately experiment shows

that, with the ordinary strength used, the eggs of this scale are not affected by such fumigation.

It has hitherto been recommended to fumigate the young stock before or soon after planting. As, however, the Mussel Scale insect is then in the egg stage, such fumigation is no longer recommended. This does not invalidate the fumigation of young stock with hydrocyanic acid gas in the case of scales, *e.g.*, the Oyster-Shell Bark Louse (*Aspidiotus Ostreæformis*), where the stock sent out for planting has on it the scale in other than the egg stage.

Natural Enemies.

Scales have many natural enemies, but this species, like the currant scale, is not materially lessened by them in this country. Amongst the natural enemies, birds alone destroy them to any appreciable extent. The tits, and a few other birds, such as the tree-creeper and wryneck, feed upon them. Tits should always be encouraged in orchard and garden. Lady-birds and their larvæ eat scale, but none seem very partial to the Mussel Scale in Great Britain. Minute Hymenoptera (*Chalcididæ*) also live as parasites upon them, but seldom do any appreciable good. Fruit growers must wash the trees and ignore the very small amount of help given by these minute parasites.

Whitehall Place, London, S.W.1,
June, 1904.

Revised, January, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

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Leaflet No. 108.

BOARD OF AGRICULTURE AND FISHERIES.

Epizootic Abortion in Cattle, or Slipping Calf.

This disease may be defined as a contagious affection of the pregnant womb caused by the bacillus of cattle abortion, which usually, though not always, results in the slipping of the immature calf.

Animals affected.

The disease is essentially a disease of cattle, but the other domesticated animals, such as the mare, the ewe, the goat, and the bitch, can be experimentally infected, and it is probable that they very occasionally contract the disease by natural infection owing to gross carelessness in the disposal of infected material from aborting cows.

The Microbe.

The microbe is a very small bacillus which may assume either an oval or a rod shape. In the discharges, and in material taken from the after-birth of an aborting cow, the microbes are often found in characteristic clumps consisting of many bacilli, and these clumps are so typical in appearance that their presence in such materials enables one to diagnose the disease with great certainty. The bacilli can be stained with any of the aniline dyes.

Virulent material and Methods of Infection.

The contents of the infected womb, that is to say, the immature calf, its membranes, and the discharge which the microbe has caused to appear on the lining inside the organ, are all infective. In many cases the microbes are also very plentiful in the stomach and intestines of the calf. The infected animals, however, are not dangerous to others until they begin to discharge the contents of the womb, but once these are discharged, they may soil the food and water supply. They may also be brought in contact with the genital organs of other animals by the latter lying on soiled litter or dipping their tails into the gutter which is so frequently to be found in cow-sheds behind the stalls. The infective material may be carried some distance by dogs and foxes. It may also be carried on the hands and the boots of attendants. If the animal aborts at a very late stage of pregnancy, and the calf is born alive, it may carry infection to another establishment owing to infective material which is in its intestines. It is particularly to be noted that unless the infective material is disinfected it may preserve its power of infection for several months. The most common and

the most important way whereby infective material is carried from one establishment to another is through the agency of affected in-calf cows and cows which have aborted, and are still discharging. The former by slipping calf may infect the new premises.

As regards the methods of infection, recent inquiry shows that infection of the pregnant womb is readily brought about if infective material be taken in by the mouth, and that this is the most important way in which natural infection takes place. The pregnant animals, therefore, can become infected by eating grass at pasture, or other food stuffs, and by drinking water, soiled by the discharge from an infected animal. Infection can also take place owing to infective material gaining entrance to the genital organs, but this method is not of so much importance in practice as infection by way of the mouth.

With regard to the bull as a source of infection, it is possible that if the bull serves a clean cow a very short time after having served an animal which has very recently aborted it may infect the former. Under the ordinary conditions of farming, however, it is seldom that an animal which has aborted goes to the bull for a month or more after the act of abortion. By this time the discharge has usually ceased, so that the bull does not run a great risk of becoming contaminated. Moreover, except in cases where a bull is under no responsible supervision and promiscuously serves a large number of cows whose owners have no particular interest in their health, it is comparatively seldom that the bull will have the opportunity of serving a clean cow immediately after it has served one which has recently aborted. The bull, then, cannot be regarded as a carrying agent of the first importance, but admittedly plays a part in the spread of abortion, and infection in this way must be guarded against.

As regards infection in the case of cows which have aborted for the second or third time in succession, it does not follow that it is owing to the persistence of abortion bacilli in their organs. It is much more likely that they have been re-infected in the ordinary way. It is to be noted that the majority of animals, at least, acquire a considerable degree of resistance to the disease after one attack, but a proportion of them fail, owing to some defect in their system, to acquire this immunity, and are thus capable of being infected more than once.

Symptoms.

No symptoms immediately follow infection, but the disease runs an insidious chronic course, and, given an infected herd, one can never be sure which animal will carry its calf to full time. Some animals may abort a little more than a month after infection, but the majority do not

do so until three or four months afterwards. Indeed, an infected animal may sometimes carry its calf practically to full time, and give birth to it alive. When this happens it may usually be considered that the animal contracted the affection at a late stage of pregnancy. When a cow aborts in the first, second, or even third month of pregnancy, the slipped calf is often expelled completely enclosed in the membranes. At later stages the membranes are frequently retained after the calf has been expelled.

Warning symptoms are more likely to be observed in animals which abort after the third month of pregnancy. These warning symptoms may last one or two days or only a few hours. A discharge from the genital organs precedes the act of abortion, it may even be by one or two days. Usually, however, the discharge does not appear until immediately before the act. The discharge generally lasts for a month after the act or somewhat less. At first only a little blood-tinged material is observed, but later the discharge is rather typical in appearance, and in the ordinary way is a good aid to diagnosis. Its colour is usually distinctly yellow, but it may be very dark brown. The more fluid parts are like pus, but clotted masses of the material are also frequently thrown out. They can be seen soiling the root of the tail or on the floor behind the animal. The condition ot the udder often furnishes a valuable symptom of approaching abortion. The gland becomes somewhat swollen, and the animal is said to be making a bag before her time. The gland may even become suddenly and prematurely active when an animal is about to abort in the later stages of pregnancy.

Prevention.

Since abortion is spread chiefly through the agency of cows which have recently aborted and those which are pregnant and infected, it is of great importance, even though the latter have not yet aborted, to keep such cows away from other pregnant cows.

Although the bull, as recent enquiry shows, cannot be considered of the first importance in spreading abortion, it would be wrong to disregard it altogether as a means of spreading the disease. The greatest danger arises where the bull promiscuously serves a large number of cows and is not under responsible supervision. When contagious abortion is prevalent among the animals belonging to owners who make use of this class of bull it would be well for those with clean herds not to send their cows to such a bull unless effective measures have been taken to prevent any cows which have recently aborted being sent to it for service, In fact, it will always be well not to send a cow to any bull on premises where contagious abortion exists, unless a reliable

guarantee can be obtained that the bull has not been used for the service of cows which have aborted within the previous two months. If, however, it be impossible to avoid sending cows to a bull which comes in contact with animals which have aborted, it should be a rule that the genital organs of the male be thoroughly washed with an antiseptic solution (such as corrosive sublimate 1—2,000) some little time before it serves, unless an assurance be given that it has been disinfected immediately after a service which might have infected it.

It has already been mentioned that an infected cow is not dangerous until it begins to discharge the contents of the uterus, and that the first symptoms of abortion frequently show themselves before the act takes place. On every establishment where breeding cows are kept these warning symptoms should always be carefully looked for, and should they be observed, the animal concerned should be removed immediately to a special shed. The stall and the immediate surroundings should at once be disinfected with a liberal quantity of quick lime. Should an animal abort before such measures can be taken it should, nevertheless, be removed from the other pregnant animals, and every part of the building with which the discharges have come in contact (these would be mainly the flooring, gutter, and stall) should be immediately disinfected. Everything which comes from an aborting cow should be destroyed, and everything which has been used for lifting or carrying the material (barrows, spades, forks, &c.) should be thoroughly disinfected. The best way to destroy the material from an aborting animal is to burn it, but if this cannot be carried out, it should be put in a pit 4 ft. deep and completely covered three or four inches deep with quick lime. After this has been done the lime should be quickly slaked by pouring very hot water into the pit, and immediately the lime has absorbed the water the pit should be quickly filled in with earth, so as to cause the heat from slaking to be retained for some time. In using quick lime as a disinfectant for material on floors, &c., a large quantity should be employed, not less than four times the bulk of the material upon which it is to act. It should be well mixed with this material, and then slaked with water as hot as possible, the object being to get a sufficient amount of heat developed during the slaking process to destroy the infective material. For general disinfecting purposes a 3 per cent. solution of carbolic acid, or a 1 in 2,000 solution of corrosive sublimate, may be usefully employed. Infected litter should be removed from the cowshed, soaked in paraffin and burned.

So long as there is any discharge from the genital organs of an animal which has aborted the genital passages should of syringed out twice a day with a mild antiseptic solution,

(3 per cent. solution of carbolic acid or corrosive sublimate 1—2,000) and the flooring behind the animal should be disinfected at least once daily. A cow after aborting seldom discharges for more than a month. Such an animal should not be brought in contact with any pregnant females until the discharge has ceased; even if the latter appears to have ceased before a month is up it will be well to keep the animal isolated for that period at least. It must be remembered also that a discharging animal should not be isolated on a pasture or in contact with a water supply, because the discharges can infect the grass and water, and, as has already been pointed out, the infective material may retain its activity for months, and so be infective. When the isolation period is completed, it is advisable to wash at least the posterior half of the animal with soap and water followed by a disinfecting solution such as a 1 in 2,000 solution of corrosive sublimate before putting the cow back amongst her fellows. It is advisable to kill or isolate a calf which has been aborted alive, as it may distribute infection from its bowels.

No animal which has aborted should be sent to market or sold to another establishment until it has undergone the proper period of isolation, and been disinfected, otherwise it may carry infection elsewhere. With some farmers it is customary to get rid of animals which have aborted. It should be pointed out, however, that animals which have suffered from an attack of the disease are usually more resistant to it than those which have not, and that by keeping animals which have aborted one may be better enabled to get rid of the disease, as immunised stock is much more useful for this purpose than new animals. It may be mentioned that it is possible that immunisation methods which are at present being tried by the Board may eventually be of considerable service in getting rid of the disease. The Board are prepared to issue vaccine, under certain conditions, for the inoculation of infected herds.

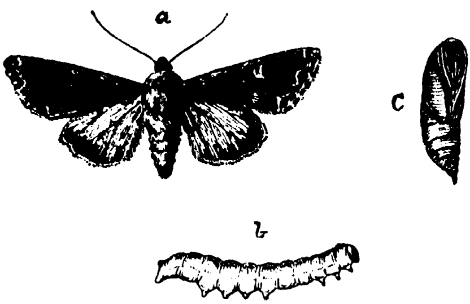
Whitehall Place, London, S.W.1,
December, 1904.
Revised, July, 1915.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 109.

BOARD OF AGRICULTURE AND FISHERIES.

The Cabbage Moth (*Mamestra brassicae*, L.).



a. Cabbage Moth; *b*. Caterpillar; and *c*. Pupa (all nat. size).

The caterpillars of the Cabbage Moth (*Mamestra brassicae*) are a great pest in gardens all over Great Britain and Ireland, and in some years do much damage. While known chiefly as a cabbage pest they are general feeders, attacking a great variety of plants, such as cauliflower, broccoli, turnip, radish, lettuce, strawberries, currants, dahlias, mallows, marigolds, roses, geraniums, dock, goosefoot, the leaves and flowers of Indian corn, tobacco, and tomato. In June, 1910, the caterpillars did great havoc in Essex among tomatoes; they were in numbers under the leaves and entered the fruits and ate out the centre. (The caterpillars were sent to the Board for determination and the moths were bred from them.)

The caterpillars are voracious and are troublesome not only owing to the quantity they devour but because parts of the plants not eaten are fouled by their excrement.

Description.

Moth.—The fore-wings (*a*) are dark grey or grey brown varied with dark and light streaks and marks; at the hind edge of the front wings is a yellowish-white zigzag line; the hind wings are smoky or grey-brown with the base pale and the fringe whitish. Down the middle of the back is a distinct crest or row of tufts. The legs are brown and very

hairy at the base. The length of the body is nearly or quite three-fourths of an inch and the wing-expanse reaches an inch and three-quarters or over.

Egg.—The egg is roundish, ribbed, and green-yellow in colour.

Larva.—The larva (*b*) is a 16-legged caterpillar, smooth, round, and with the 12th segment somewhat raised. The head is smooth and shining brown or yellow-brown. The colour of the body varies much. Generally it may be said that the upper surface is darker than the under-surface, the former being more or less brown or smoke coloured, the latter grey-green or yellowish and spotted. The newly-hatched caterpillars are greenish, and sometimes more or less of the green colour is retained; on the other hand the caterpillar is often quite dark on the upper surface, which bears triangular marks with light dots in them. Sometimes there is a prominent dusky line down the back. The spiracles are white surrounded with black. The legs are of the same colour as the under surface of the body. The length of the full-grown caterpillar is, on an average, an inch and a quarter, but it may be more; the caterpillar when disturbed rolls itself into a ring.

Pupa.—The pupa (*c*) is shining brown with occasional darker areas, or black brown; the hind end terminates in a process.

Life History.

The Cabbage Moth appears on the wing from May onwards during the whole summer.

The moths rest in the daytime on tree-trunks, palings, stones, sometimes under cover in barns and rooms; they fly and pair at night. The eggs are laid singly on the leaves of cabbage, cauliflower, and other cultivated and wild plants. The caterpillars which hatch take a month and over, according to the conditions, to complete their growth. When full grown they enter the soil for pupation: the pupæ lie naked in the soil or they may be in a cell of earth. From summer pupæ new moths may come in the same season, and thus a second brood of caterpillars may be produced.

The winter is typically passed in the chrysalid condition in the soil, but sometimes the caterpillar remains as such over winter, not pupating till the next spring. On the average a calendar for the year for this species would be: Moth, May to September; larva, June to October; pupa, September to May.

The mode of feeding of the caterpillars varies according to the plant infested. On some plants the caterpillars feed externally, and leaves, *e.g.* those of the turnip, may be devoured to the midribs. On the other hand, on cabbage

the caterpillars may not be observed on the outside of the head or between the outside leaves, because of their having bored to the very heart of the cabbage; the caterpillar galleries are full of ejecta moist with the juices of the plant, and, especially in wet weather, the whole centre becomes a foul mass.

Methods of Control.

1.—All pupæ turned up, when the ground is dug in winter, should be destroyed. If large areas of cabbage have been attacked poultry should be turned on to the land; the birds will greedily eat the pupæ turned up by digging or ploughing.

2.—In gardens the larvæ should be picked off by hand but it is necessary to watch carefully for the first signs of attack and to begin picking at once.

3.—The plants may be sprayed or watered with salt and water (common salt 2 ozs., water 1 gallon) or with soap and water (hard or soft soap 1 oz.—1½ ozs., water 1 gallon).

4.—If the simple solutions mentioned in (3) are not effective, the following suggestions may be considered:—Naphthalene emulsion, which may be bought from insecticide makers, is recommended in India in connection with similar problems. In America a nicotine insecticide is often suggested and reports have also been received of the use of hot water (temperature about 130° Fahr.) without the addition of any insecticide. Dilute solutions of proprietary disinfectants or disinfectant soaps are said to have given good results.

5.—Finely powdered slaked lime or old gas lime is sometimes used for powdering over the plants. A mixture of slaked lime and tobacco powder (lime 4 lbs., tobacco powder 1 lb.) is more effective.

Whitehall Place, London, S.W.1,
October, 1904.
Revised, September, 1915.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.]

Leaflet No. 110.

BOARD OF AGRICULTURE AND FISHERIES.

Carriage of Goods by Rail at Owner's Risk Rates.

Owner's risk rates are rates made by special contract, under the provisions of Section 7 of the Railway and Canal Traffic Act, 1854. They are generally lower than the ordinary rates, and in consideration of the reduction in the rate, the contract, which must be signed by the trader, and is only enforceable at law if its conditions are held to be just and reasonable, relieves the railway companies from their ordinary liability as carriers, except in the case of the wilful misconduct of their servants. Sometimes the consideration for the contract is not a reduction in rate, but the acceptance unpacked of goods liable to breakage or damage.

Traders have frequently complained that the terms of the existing contract pressed unduly upon them, and the subject came before the Railway Conference in 1908 for consideration. The Railway Conference, on which the Board of Agriculture and Fisheries were represented, was constituted by the Board of Trade, with the object of reviewing some of the more important questions that are raised from time to time between the railway companies on the one hand and the traders and general public on the other.

The grievances put forward on the part of the traders were mainly twofold :—(1) that the companies ought not only to be liable for wilful misconduct, which was difficult of proof, but should also pay compensation in extreme cases in which, for example, loss or damage was occasioned by the grosser forms of negligence on the part of the companies' servants; and (2) that owing to the lowness of the owner's risk rates as compared with the corresponding company's risk rates, they are the only rates commercially possible for the ordinary trader.

The answer of the railway companies was that the reduced rates at owner's risk are a concession to the trader, and are the subject of a purely voluntary contract between the parties, which is almost invariably based upon other considerations as well as that of risk, and that it is always open to a trader to have his goods carried subject to conditions applicable to railway carriers at a rate within the company's statutory maxima, and that these had been recently settled by the Acts of 1891 and 1892.

The subject was fully discussed at the Conference, and certain amendments were suggested and it was ascertained

that with a view of settling this controversy railway companies generally were willing to adopt these suggestions.

The Board of Trade have since been informed that the English and Scottish railway companies adopted as from January 1st, 1910, the recommendations made by the Conference.

The amendments are as follows :—

I.—*Goods carried in Merchandise Trains.* — The following addition to be embodied in the present consignment note for goods to be carried at owner's risk in merchandise trains, after the words "wilful misconduct of the Company's servants," viz. :—

But nothing in this agreement shall exempt the Company from any liability they would otherwise incur in the following cases of non-delivery, pilferage or misdelivery except on proof that such non-delivery, pilferage or mis-delivery has not been caused by negligence or misconduct on the part of the Company or their servants.

1. Non-delivery of any package or consignment fully and properly addressed, unless such non-delivery is due to fire or accidents to trains.

2. Pilferage from packages of goods protected otherwise than by paper or other packing readily removable by hand, provided the pilferage is pointed out to a servant of the Company on or before delivery.

3. Mis-delivery where goods fully and properly addressed are not tendered to the consignee within twenty-eight days after despatch.

II. — *Perishable Merchandise carried in Passenger Trains (other than Milk in Cans).*—The following addition to be embodied in the consignment note for perishable and other merchandise (other than milk in cans), carried at owner's risk in passenger trains, after the words "wilful misconduct of the Company's servants," viz. :—

But nothing in this agreement shall exempt the Company in the case of perishable merchandise as defined by the Railway Rates and Charges Order Confirmation Acts, 1891–92 (other than milk in cans), from any liability they would otherwise incur in the following cases of non-delivery, pilferage or delay, except on proof that such non-delivery, pilferage or delay has not been caused by negligence or misconduct on the part of the Company or their servants.

1. Non-delivery of any package or consignment, fully and properly addressed, unless such non-delivery is due to fire or accidents to train.

2. Pilferage from packages of goods protected otherwise than by paper or other packing readily removable by hand, provided the pilferage is pointed out to a servant of the Company on or before delivery.

3. Delay in transit exceeding forty-eight hours of any package or consignment, fully and properly addressed, as a result of which the value of the goods is deteriorated to the extent of three-fourths, if such deterioration is pointed out to a servant of the Company on or before delivery. Provided that in such case the Company's liability shall not exceed one-half the diminution in value of the goods.

III.—*Milk in Cans carried in Passenger Trains.*—The following modification to be embodied in the conditions of carriage for milk in cans carried at owner's risk by passenger train, viz. :—

Except in the case of milk carried oversea nothing in this agreement shall exempt the Company from any liability they would otherwise incur in the following cases of loss or delay, except on proof that such loss or delay has not been caused by negligence or misconduct on the part of the Company or their servants.

1. Loss of milk through non-arrival at the station to which it was consigned of a can fully and properly addressed, unless such non-arrival is due to fire or accidents to trains.

2. Delay in transit exceeding twenty-four hours to the station to which it was consigned of milk in cans fully and properly addressed, as a result of which the value of the milk is deteriorated to the extent of three-fourths, if such deterioration is pointed out to a servant of the Company on or before receipt by the consignee. Provided that in such case the Company's liability shall not exceed one-half of the diminution in value of the milk.

Carriage of Milk by Rail in Sealed Churns.—Attention is drawn to the fact that, according to information furnished to the Board by the Railway Companies Association, milk cans with lids sealed or otherwise fastened are conveyed by the Railway Companies at the same rates as are charged for milk in cans not sealed or otherwise fastened, provided the tare weight is stamped on the outside of the cans.

The Companies will in such cases accept the declaration of the senders as to the quantity contained in the can. They reserve to themselves the right to open the can to ascertain that the quantity contained therein agrees with the quantity declared, but this reservation is only intended as a protection against fraud and a can would only be opened in a case

where there was reasonable ground for believing that it contained a greater quantity of milk than had been invoiced.

It is, therefore, open to farmers to protect themselves against loss or other interference with milk while in transit by sealing or otherwise fastening their cans.

Whitehall Place, London S.W.1,
May, 1910.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 111.

BOARD OF AGRICULTURE AND FISHERIES.

INCREASING PROFITS FROM EGGS.

Value of Co-operative Selling.

£9,500,000 spent in Foreign Eggs in 1913.—The people of this country paid the enormous sum of £9,500,000 in the year 1913 for imported eggs. There is no reason why the greater part of this money should not have been spent in the purchase of eggs produced at home. One of the best means of encouraging the increased production of eggs is to form Co-operative Egg and Poultry Societies.

The Co-operative Societies.—In a district where a Co-operative Egg Society is established, increased prices may reasonably be expected for eggs graded by the society. Poultry keepers, therefore, should at once combine and establish, in their own interests, local societies of this character. As an example of what a Co-operative Society may do to stimulate production it may be said that one of the most successful societies sold over 8,000,000 eggs in 1916.

How to Form such a Society.—The first step should be to obtain the advice of the Agricultural Organisation Society, Queen Anne's Chambers, Westminster, S.W., who will give all necessary assistance. The next step is to register the society under the Industrial and Provident Societies Act of 1893, in order that it may have a legal existence and be able to enter into contracts. If, as is often the case, there is already in the district an Agricultural Co-operative Society it would probably be better to add the sale of eggs and poultry to its operations rather than form a new society.

Method of Working and Collecting the Eggs.—The method of working adopted by a society usually involves the establishment of a depôt in a convenient position, as near as possible to a railway station, and arrangements must be made for collecting, receiving, testing, grading, packing and selling the eggs on behalf of the members. In order to secure a

good reputation for the society's eggs and to obtain the best prices, eggs should be sent to or collected by the depôt daily, or at the least three times a week, no matter how few there may be from each individual member. This method will ensure that the eggs are fresh and of the highest value in the market.

When birds are broody, eggs should be taken from the nests twice a day, as if they remain under the hen for several hours they are apt to be spoiled. Every care should be taken to keep the shells free from dirt. The nests should, therefore, be kept clean and the eggs collected frequently, especially during wet weather. Washed eggs lose much in appearance and do not keep so well.

Testing Eggs at Depot.—When received at the depôt every egg should be tested for freshness by means of a special lamp. The trade requirements for "new-laid" eggs are that they shall be—

(1) Clean in the shell and of good shape.
(2) Full, *i.e.*, have a small air space.
(3) Bright, *i.e.*, perfectly clear without any spots or shadows.
(4) From 2 to 2¼ oz. in weight.

Eggs should be packed in conformity with trade requirements, *i.e.*, in 10, 20, 30, or 40 dozen boxes, and forwarded to their destination.

How to Obtain Best Prices.—Societies should endeavour to deal directly with retail traders. The societies have a great advantage over individual producers, who are unable to ensure a regular supply to meet the requirements of traders. In the case of poultry for table purposes it frequently happens that, owing to a more regular demand, better returns are obtained in the wholesale markets.

Preserving Eggs.—In the spring supplies are often in excess of the demand, and in order to avoid throwing large quantities on the market at low prices, societies have found it profitable to preserve their surplus eggs. A Leaflet (No. 83) on *The Preservation of Eggs* can be obtained on application to the Board.

Supply of Poultry Requisites.—Societies may also find it advantageous to buy poultry foods and appliances at wholesale rates for sale to members at prices below the usual retail prices.

Area covered by a Society.—A society can be formed for two or three adjacent villages or for a still larger district. In the latter case, to minimise the cost of collection, sub-collecting stations should be established in conjunction with a central packing depôt.

Whitehall Place, London, S.W.1,
August, 1904.
Revised, April, 1917.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 112.

BOARD OF AGRICULTURE AND FISHERIES.

Weeds and their Suppression.

The Board desire to call the special attention of farmers to the great need for combating weeds, which are usually responsible for heavy loss in the yield of crops. At the present time it is most important that the maximum yield of foodstuffs should be obtained from the land, and this can only be done by keeping the land free from weeds, and in a high state of cultivation, and by sowing pure seed of high germinating power. The present leaflet is devoted to a general consideration of weeds and their eradication.

In this connection it may be remarked that in a Memorandum issued last year by the Farmers' Club it is observed that, "The biggest waste in agriculture is caused by weeds. As a rule, weeds are permitted by bad farmers only, and a determined attempt, notwithstanding all difficulties, should be made to get rid of the weeds so that the yield per acre of the crops we grow may attain the highest standard."

Damage done by Weeds.

The most serious objections to weeds may be stated as follows :—

1. They absorb from the soil moisture and plant food which would otherwise go to nourish and increase the crop which is being cultivated.
2. They "crowd" the crop, restricting the amount of light, heat and air necessary for healthy growth and for the proper assimilation of plant food. The effect is to hamper the growth of the plants during early life, especially in the case of crops of slow growth, while they prevent or retard ripening and drying, particularly in the case of corn crops. The straw of cereals may be weakened and rendered liable to "lodge," thus making the work of cutting at harvest both difficult and expensive.
3. Weeds, especially such climbing kinds as bindweed and cleavers, hamper harvesting of corn crops, both as regards cutting and drying.
4. Weeds interfere with, and render more expensive, proper and thorough cultivation, and the "singling" of root crops.

5. Weeds may harbour, or favour the development of, insect and fungus pests.
6. The value of samples of cereals is reduced by the presence of cockle, garlic, cleavers, and wild vetch; the value of most farm seeds is lowered by the presence of the seeds of weeds; and the market value of hay and other farm produce is similarly reduced by certain weeds or their seeds.
7. Some weeds—*e.g.*, garlic—taint the milk of cows which eat them, whilst others—*e.g.*, meadow saffron and water hemlock—are poisonous to stock generally.
8. Other weeds (dodder, broomrape, yellow rattle) are parasitic or semi-parasitic, and directly feed upon the crops they infest.
9. The underground stems and roots of weeds may cause the stoppage of drains.

Most farmers recognise that it is impossible to obtain the best returns from the land when weeds are allowed to grow unchecked. Experiment has shown that on a properly weeded area of arable land the crop may be double that on an unweeded area; *e.g.*, in one case mangolds, grown under otherwise exactly similar conditions on the same field, yielded 37¼ tons per acre where two hoeings were given, and only 16¾ tons where there was no weeding after singling.

Manner of Distribution.

Before the suppression of weeds can be intelligently dealt with, it is essential to have a clear conception of the manner in which weeds obtain access to the farm, and the methods by which they are spread broadcast amongst cultivated crops. The manner of distribution is very varied, but amongst the commoner processes are:—

a. Distribution by means of the wind. Many seeds, like those of the poppy, are so small that they are readily scattered considerable distances from the parent plant.

b. Distribution by means of a special parachute-like apparatus, or other arrangement, of fluffy hairs and flattened wing-like projections, by which seeds, such as those of the thistle, dock, groundsel, etc., are rendered buoyant, and easily carried about in a light breeze.

c. Distribution by means of farmyard manure. Screenings from threshing and winnowing-machines, and sweepings from barns and hay-lofts, often find their way to the manure heap, while manure from cattle fed on inferior hay is also likely to contain weed-

seeds. Many seeds of weeds may be uninjured by the heat of fermentation, and will in due course pass on to the fields. Some seeds may even germinate better after lying in the manure heap, or after passing through the stomach of an animal. Well-rotted farm-yard manure will, however, contain fewer germinable weed seeds than fresh manure, and is therefore less liable to introduce weeds.

d. The use of impure seed* is a potent means of introducing weeds to a farm. The presence of 1 per cent. of dock seed in a mixture of grass and clover seed means *ten or more dock seeds per square yard* all over the field wherever such a sample is sown at the ordinary rate for leys.

e. Some weeds—*e.g.*, creeping thistle, couch, field bindweed, onion couch—are spread by means of broken portions of the rootstock, which may be carried from field to field or farm to farm in a variety of ways.

Methods of Suppression.

Weeds may be *annual*, *biennial* or *perennial*, and must be combated by somewhat different methods according to their habit of growth. It must be emphasised that, whatever methods are adopted, they must be promptly, vigorously and faithfully carried out : systematic well-timed effort is the foundation of success.

1. The most obvious means of suppressing weeds is to prevent them seeding. When it is recognised that an ordinary charlock plant produces from 1,000 to 4,000 seeds, and a moderate-sized poppy 10,000 to 15,000, and large plants 50,000 seeds, the force of the adage that "one year's seeding is seven years' weeding" is obvious. Further, as many weeds produce seeds which do not germinate uniformly, the mischief is greater than appears at first sight, for they may lie dormant in the soil and grow after several years. In destroying weeds of this type the frequent recurrence in the rotation of root and other crops which permit thorough cleaning is an advantage (*see* also 4, 9, 13). Seeding of weeds growing in hedgerows, on roadsides and waste places, and round farm buildings, should similarly be prevented.

* *See* Leaflet No. 297 (*Seed Testing*) which clearly shows the need which exists for farmers to exercise the greatest possible care in purchasing their seeds.

2. Under no circumstances should imperfectly cleaned seed be either purchased or sown. *The Board desire to impress upon farmers the great importance at the present time of taking steps to ensure that there shall be no failure of crops due to the sowing of poor seed.*

   Care should be exercised as to the disposal of refuse seeds from threshing, screenings, sweepings of haylofts, etc. Such refuse should be burnt.
3. Deep ploughing is sometimes resorted to with considerable success, many seeds rotting when deeply buried. Others, however, remain dormant under such conditions, without losing their vitality, and may subsequently be brought to the surface. Where practicable shallow cultivation and the preparation of a good tilth prior to the sowing of a crop will encourage the seeds to germinate, when they may be destroyed by further stirring of the soil. Such a method will help to clear the ground of many annual and biennial weeds, such as poppy, charlock, and some species of thistle.
4. In view of the present shortage of manual labour, in districts where hand-hoeing is usually largely practised, corn crops may usefully be drilled in rows wide enough apart to permit of horse-hoeing, say, 8 in. to 9 in. apart. This is especially useful in the case of spring-sown corn.
5. Where horse-hoeing cannot be practised, the wetter the climate, or the more the land is subject to the growth of annual weeds, the closer the drill coulters should be set. When weeds are plentiful it is advisable immediately after harvest to disc or lightly scarify the surface, with a view to encouraging the germination of annual weeds. These should afterwards be ploughed down.
6. The eradication of perennials, such as couch, field bindweed, and creeping thistle, needs careful and well-directed effort. These plants are propagated by underground runners bearing buds, and the object should be to remove the rootstocks as far as possible unbroken. This will usually be best accomplished by shallow ploughing followed by grubbing or cultivating, rolling and harrowing. The weeds should be collected and either be burnt or made into a compost with lime. Sometimes, however, as in fallowing, they may first be brought to the surface and left to the drying effects of wind and sun.
7. Hand-pulling, digging with fork or spade, and total removal of weeds are efficient means of destruction,

but these methods are all expensive, and are only resorted to when other plans have failed or are inapplicable. In every case the weeds collected should be burnt.

8. Any perennial weeds may be cut down frequently to exhaust the supplies of food stored up in their root-stock, and prevent storage of further supplies. Judicious cutting with spade, hoe, or scythe, will destroy all weeds if the cutting is repeated often enough. Many weeds when cut near the ground send up new stems, and these are produced at the expense of food stored below ground in the previous season. The growth of these secondary stems weakens the plant as a whole, and if, when produced, they are immediately cut off, and the process repeated, total destruction will be the result, no matter what the plant may be.

   The first cutting should be made early in the year, and as often after that, during the summer, as new shoots appear. If left too long the weeds may either seed, or again store up food in the roots in preparation for the next season's growth. One cutting in the case of perennials like creeping thistle, field bindweed, couch, and coltsfoot is quite valueless.

9. Fallowing, either bastard or bare, as a cleaning process, is largely practised with good results on the heavy classes of soils on which root crops are uncertain and expensive to produce. At present, however, bare fallowing should be reduced to a minimum, "smother" crops being introduced (*see* 13).

10. Rushes, sedges and horsetails are indicative of a sour soil, which can be remedied by draining and liming. A dressing of lime is, more or less, a specific against sorrel, corn marigold, spurrey, and some other weeds.

11. The application of dung and artificial manures induces considerable changes in the character of the herbage on pastures, and of the weeds on arable land. The application of 5 to 8 cwt. of basic slag per acre to pastures on stiff clay land often has a wonderful effect in encouraging clovers and generally improving the herbage, while a mixture of superphosphate and sulphate of ammonia is often an effective means of reducing such weeds as buttercups, daisies and plantains. Suitable manuring may so stimulate cultivated crops that many of the worst weeds will be crowded out, a fact which is of especial significance at the present time in connection with the growing of successive corn crops.

12. Farmyard manure, believed to contain weed seeds in any quantity, should be allowed to rot well before application to the land. Many weed seeds may be present when meadow hay and chaff (barren glumes) of oats are fed to stock.
13. Weeds may often be suppressed or much reduced by the growth of dense, heavy "smother" crops which choke them out. On foul land such crops may be of much value before or after a well-hoed root crop. Suitable crops for the purpose are vetches, or a mixture of vetches, peas, oats or beans; mustard, rape, and maize. The last-named is especially valuable, because it is not only thoroughly hoed but casts a dense shade. It can, however, be grown only in the warmer southern counties.

    Where weeds are likely to be abundant it may prove a good plan to sow part of the root "break" with a vetch mixture in autumn. This would not only "smother" out weeds, but reduce the labour bill for roots.

    Under the Norfolk four-course rotation the area devoted to roots imposes a severe strain on labour, even in normal times. At the present time, all indications point to the necessity for modifying the usual practice. It is well known that success in root-growing and the welfare of the crops that follow depend largely on careful, thorough, and persistent cultivation of the root "break." It is desirable, therefore, that farmers should adopt every practicable means of suppressing weeds at all stages of the rotation, as, for example, by the growth of heavy corn crops, and they should include in the root area such crops as will suppress weeds, save labour, and provide suitable supplementary keep for stock in winter. (*See* Special Leaflet No. 28, *Suggestions for the Cultivation of Catch Crops and Home-Grown Feeding Stuffs*, and Special Leaflet No. 43, *Suggestions for Saving Labour*.)
14. Close feeding with sheep will often check certain plants and prevent them seeding, *e.g.*, ragwort, yellow rattle, and hardhead or knapweed.
15. Finally, spraying crops with chemical substances, more especially with sulphate of copper* (bluestone) and sulphate of iron, has been found exceedingly useful in destroying weeds. The destruction of charlock in corn crops by spraying is dealt with in Leaflet No. 63. Solutions of the sulphates of copper

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* This material is scarce and dear at present.

and iron, however, may be employed against other weeds, some of which may be destroyed and others crippled. Persicaria or red-shank and spurrey may respectively be killed by spraying with 4 and 5 per cent. solutions of copper sulphate; while the following weeds are more or less crippled and seeding largely prevented by spraying with a 5 per cent. solution of copper sulphate, or a 15 per cent. solution of sulphate of iron :—Poppy, corn cockle, black bindweed, dock, groundsel, dandelion, perennial sow thistle, cornflower, thistles, and coltsfoot.

Labour.

During the past year, no doubt largely owing to shortage of labour, weeds were unusually plentiful in many districts.

The shortage in manual labour may largely be met in so far as the destruction of weeds is concerned by the employment of women and children, working when necessary in gangs in charge of one or two older and practised hands; and of temporary workers who may be in a position to do work of this kind for short periods. In regard to labour, farmers should make much more use of the Local Labour Exchanges. (*See* also 4, 13.)

Whitehall Place, London, S.W.1,
June, 1904.
Revised, April, 1916.

NOTE.—Other Leaflets dealing with weeds are :—

No. 63. The Destruction of Charlock.
No. 166. Some Common Thistles.
No. 180. Dodder.
No. 194. Coltsfoot.
No. 222. Meadow Saffron.
No. 226. Broom-rape.
No. 249. "Couch" or "Twitch."
No. 251. Some Common Weeds.—I.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 113.

BOARD OF AGRICULTURE AND FISHERIES.

Dry Rot.

In practically every house in this country fungi are to be found growing on the woodwork or floor. Some of these are mere moulds, feeding feebly and slowly on the surface of the wood; others obtain their food from the soil or from dirt. Both of these classes are relatively or absolutely harmless so far as the destruction of wood is concerned. On the other hand, some of the remaining fungi met with cause deep-seated rotting and eventual destruction of the wood-fabric, and are known as "dry rot" fungi.

Popular Distinction between Dry Rot and Wet Rot.—Practical men distinguish between "dry rot" and "wet rot." They describe as "wet rot" such decay as is started in the standing tree or is already present in the unconverted log. As the fungi causing this form of rot chiefly attack the standing tree, they are known as parasites (even though in reality they often attack only the dead wood of such trees). By "dry rot" practical men mean the form of decay induced in timber that is apparently sound when first used as constructional material. Inasmuch as fungi commonly causing dry rot in houses in this country are largely not parasitic on trees, this popular distinction between "dry rot" and "wet rot" is partly justified.

Fungi causing "Dry Rot."

The fungi causing "dry rot" in different structures (houses, mines, railway sleepers) in this country, and in different regions of the world, are by no means identical. For instance, *Merulius lacrymans*, the most malignant and widespread species occurring in the houses of north-temperate lands, is said to be lacking in the tropics; and this is borne out by experiments showing that moderately high temperatures, lower than those prevailing in the tropics, normally stop the growth of this fungus. There is no exhaustive list of fungi causing dry rot in this country available, and only a few of the species chiefly responsible have been investigated. This is to be regretted for two reasons: first, the enormous annual loss due to dry rot in this country will increase because of the wider use of sapwood, the lack of proper seasoning, and inadequate ventilation; secondly, the most efficacious method of treatment of each variety of dry rot can be adopted only when detailed knowledge of the conditions of existence and distribution of the particular fungus concerned is available.

At this stage a brief account may be given of the domestic form of *Merulius lacrymans*, by far the most common and destructive of all dry rot fungi, supplemented by comparative references to two other important types, *Coniophora cerebella* and *Polyporus vaporarius* (=*Poria vaporaria* of some authors).*

The mycelium (or spawn) of the fungus forms white spreading strands which grow very rapidly and spread in every direction over surrounding objects. Under certain conditions the mycelium forms thicker cushion-like plates which are the fructifications. These are usually pancake-shaped, flat, rust-coloured structures showing white margins (*see* figure). The rusty surface is marked by meandering ridges, the flanks of which bear spores innumerable by means of which the fungus is reproduced. Such flat fructifications occur on horizontal supports, but some of them, especially those facing upwards, are sterile. On vertical or oblique supports the fructifications assume the form of brackets, the rusty, fertile surface facing downwards. This surface often shows the ridges uniting and thus producing irregular "pores" recalling those of a *Polyporus*. The margins of these pores may be drawn out into more or less large teeth, resembling small stalactites. The fructifications of *Polyporus vaporarius* being white in colour, are easily distinguished from those of *Merulius*, though their "pores" may be shallow and uneven depressions, or deep, fringed tubes. The fructifications of *Coniophora cerebella*, on the other hand, are often mistaken for those of *Merulius*, but the surface of the former is raised into isolated little bosses rather than into folds.

The spores of *Merulius lacrymans*, though thin-walled, are, when kept dry, long-lived and retain their vitality for at least many months. It is quite erroneous to suppose that they germinate only in alkaline solutions: on the contrary they germinate in water and in various neutral and acid solutions (including one per cent. citric acid). Until recently, however, investigators failed to cause these ubiquitous spores to germinate upon and infect wood: but it has now been proved that they germinate freely and invade wood previously attacked by certain other wood-destroying fungi, including *Coniophora cerebella*. This incidental co-operation between the two species goes further and has important practical bearings. *Coniophora* demands for its growth in wood a large supply of moisture; hence, if wood be protected against excess of moisture it is guarded against this fungus directly, and *Merulius lacrymans* indirectly. *Merulius lacrymans*, on the other hand, once established, can manufacture water and thereby moisten and attack the driest wood, and incidentally render the latter open to attack from *Coniophora*.

* Under this name a number of different races or even species are included.

Merulius lacrymans, having once gained entrance to the woo'l, exhibits two different forms of active growth. On the one hand it sends into the wood numerous fine hyphae, which feed upon the wood-substance and so

DRY ROT,

Showing the fructifications with white sterile margins of the fungus *Merulius lacrymans*.

destroy the whole fabric. On the other hand, the fungus gives forth numerous hyphae which run over the surface of the wood, weaving themselves into cord-like strands, thin skin-like sheets, or producing thick soft cushions. This superficial mode of development is important, for it

characterizes certain fungi causing the worst forms of dry rot and enables them to spread rapidly. As the superficial mycelium spreads, it sends fine hyphae into the underlying wood. The usual method of behaviour of certain other fungi attacking the wood of living trees or felled timber is quite different. These, having once penetrated the wood, develop mainly inside it, growing in various directions but keeping at some distance within the surface except when producing fructifications; their advance is consequently slow compared with that of *Merulius*, *Coniophora*, and *Polyporus vaporarius*. By means of its superficial mycelium *Merulius lacrymans* can advance far over innutritious surfaces, such as brick-walls, along metal tubes (for bell-wires, water), and can even penetrate the mortar of walls, and thus gain entrance to other rooms. In this manner, especially by means of the skin-like mycelium or of the long string-like strands (often many yards in length), infection is transmitted to distant wood-work. Similar cords are possessed by *Polyporus vaporarius* and *Coniophora cerebella*, those of the latter being very abundant and familiar, as slender, often nearly black, threads branching over moist decaying wood in buildings.

Apart from giving strong *prima facie* evidence of the presence of the dry rot, these fungal cords are of practical importance in that they possess greater powers of resisting drought than other growths of the fungus. In addition as their structure varies with the species they aid in the identification of the *particular* species of fungus present.

In *Merulius lacrymans* such a cord shows three different kinds of tubular hyphae :—(1) ordinary hyphae, of normal width and normal thickness of cell-wall ; (2) very wide long tubes, comparable with the vessels of flowering plants, and serving to convey water containing nutritive material ; (3) strong, fibre-like hyphae, whose thick walls enable them to act as mechanically strengthening constituents. Without going into details, it may be stated generally that the older accounts with reference to the structure of the cords of the different species are not correct, and that the broad differences are quantitative rather than qualitative. For instance, *Polyporus vaporarius* has only very scanty vessel-like hyphae, but very abundant fibre-like ones, so that even when old and dry its cords are tough, not brittle as are those of *Merulius lacrymans*.

Other features in the mycelia facilitate the recognition of the different kinds of fungi. While the cords of *Coniophora* are characterized by their very early assumption of a brown colour, the general white mycelium of *Merulius lacrymans* when growing in a confined space often has the unique character of undergoing a *subsequent* change to a bright yellow colour.

Conditions favourable to Dry Rot Fungi.

The fungi causing dry-rot are active or even existent only when certain conditions are present.

Moisture.—Wood-destroying fungi during activity demand appropriate supplies of water and oxygen; such fungi cannot grow inside wood except when it contains moisture within certain limits. These limits vary with the species, though they seem to be approximately constant in range for the same species. On the one hand *Coniophora cerebella* requires that the wood shall be thoroughly moist, and is therefore most frequently found in damp cellars (and in Germany is termed the "cellar fungus"). This characteristic is so marked that the mere presence of this fungus suffices to indicate excessive dampness in a building. On the other hand *Merulius lacrymans*, when it has once gained a footing, can grow in the driest wood. This remarkable faculty *Merulius* owes to its power of producing water, which is to be seen on the tips of its exposed hyphae and is responsible for the specific name *lacrymans*. This water is not pumped out, as in the case of the leaves of certain plants, but is the result of specialised chemical activity. The fungus indirectly converts portions of its main food-material, wood, into carbon dioxide and water. *Polyporus vaporarius* possesses the same power but to a less extent. It is largely this high power of adding moisture to dry wood that renders *Merulius lacrymans* the most malignant source of dry rot in this country. When the fungus has attained a certain size local shortage of water leads to the production of cords and skin-like mycelia on exposed surfaces, as well as of fructifications.

Temperature.—The fungi causing dry rot in this country are also considerably affected by temperature. *Merulius lacrymans* and *Polyporus vaporarius* both behave as plants thriving only at moderate temperatures; according to R. Falck the highest temperatures at which the normal domestic form of the former will grow is between 26° and 27° centigrade.* The mycelia of both species are rapidly killed by exposure to a temperature of only 40° centigrade,† so that wood infected by them can easily be sterilized by heat that does not damage it. Spores and the fungi themselves are rapidly killed by steam. The resistance to low temperatures is greater, for *Merulius* can endure freezing cold.

Measures of Control.

The various kinds of fungi causing dry rot show widely different powers of attacking timbers. At the one extreme stands *Merulius lacrymans*, capable of destroying the

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* 26–27° C. = 79·80° F. approximately.
† 40° C. = 104° F.

sapwood and heartwood of many kinds of "softwoods" and "hardwoods," ranging from ordinary pine to resistant teak. At the other extreme is *Lenzites saepiaria*, a fungus occasionally causing trouble in buildings and coal mines, which causes decay only in softwoods (conifers) and especially pine. The virulent versatility of *Merulius lacrymans* helps to render it the most dangerous destructive agent of woodwork in buildings.

In adopting practical measures to deal with dry rot it is necessary to distinguish sharply between preventive and remedial measures. In both instances a knowledge of the identity and behaviour of the fungi concerned is of paramount importance, but unfortunately at present this knowledge is very incomplete.

Preventive Measures.—1. The first obvious preventive measure is to store wood under conditions least likely to encourage dry rot and to guard against contact with infectious material, including spores. In this connection it should be borne in mind that the domestic form of *Merulius lacrymans* never grows on the wood of living trees, and is probably very rare in woodlands. Original infection of wood in houses by this form of dry rot must probably be traced in the overwhelming majority of cases to the timber yard or builder's yard, or to neighbouring buildings. Lack of proper sanitation in places where sawn wood is stored, and carelessness in allowing the diffusion of infected material removed from buildings, are responsible for the original infection in probably the majority of cases: all such material should be destroyed on the spot, and tools which have come into contact with it should be thoroughly disinfected before removal.

2. A second means of preventing infection is to avoid conditions favourable or essential to the development of fungi. Modern methods of building, involving hasty work and rapid completion and the use of inadequately seasoned timber, induce conditions favourable to the spread of dry rot. The older method of completing the carcass of the house and leaving it to dry for the winter and early spring before joinery was fixed undoubtedly prevented the development of fungi. Equally important was the use of sound timber for joinery; dry timber kept dry is resistant to dry rot, and sound, air-dried, well-seasoned timber should alone be used in building. But in order that timber may remain sound it is necessary that the building should be so constructed as

(*a*) to avoid the use of methods or materials which will bring woodwork into contact with moisture, and

(*b*) to ensure a thorough system of ventilation throughout so that no corner remains unventilated, where air can stagnate and moisture accumulate, whether

between floors or behind woodwork. Such precautions directly keep at bay fungi, such as *Coniophora cerebella*, that confine their attacks to moist wood, but they also indirectly greatly decrease the chances of infection by *Merulius lacrymans*.

In the construction of foundations, burnt ballast and hygroscopic stones should as far as possible be avoided; in some districts, however, clean gravel or impervious stones are unobtainable and too costly to import; burnt ballast or local stone must then be used, and if cost allows cement substituted for Lias lime in concrete. The top soil, especially if containing vegetable matter, should be removed before filling is commenced, and all filling material should be perfectly dry and free from infection. The use of iron and cement in the construction of underground rooms and ground floors gives the greatest security against dry rot; cement should in any case be substituted, wherever possible, for mortar, but the cost is usually prohibitive.

Woodwork should be prevented from contact with masonry and mortar. This may be secured by enveloping the ends of beams in cement, asphalt, lead or zinc; in most cases the cost is prohibitive, and as an alternative the beam ends may be treated with a disinfectant. Although in all houses there is now a damp course, the common method of arranging the sleeper walls on the main walls appears to be dangerous, since the back of the plate is in direct contact with the wall and there is usually a bed of mortar between the wall and the plate. If the sleeper wall is erected independently, the plate is entirely detached from the wall and need have no mortar on the underside: the ends of the joists and boarding can also be kept clear of the wall, thus affording the maximum protection both from rising moisture and condensation on the walls.

The underside of floors need thorough ventilation. Air bricks should be placed in such numbers and position as to secure that a current reaches to all parts. It should be remembered that air bricks measuring 9″ × 3″ have actually an inlet of only 9 square inches. The most effective ventilation is provided by an air flue connected with the spaces under the floors: this may adjoin the smoke flue with a thin tile wyth between, the heat thus assisting the updraught. The efficiency of a vent flue for ventilating the whole of the space under a floor depends entirely upon its position in relation to the external wall in which the airbricks are placed: more than one flue may in some cases be necessary.

The close-jointed flooring now in common use admits of no ventilation between the boards, and it is advisable when this is used to insert gratings in the floors or skirtings (in the latter case connected with the underside of the floor by flues).

The pugging of floors in order to deaden sound is a frequent source of dry rot*: lime and hair pugging which must always be put in wet is objectionable; slag wool, silicate cotton or mack slabs are preferable; if lime and hair are used an adequate time for drying should be allowed before floor boards are laid. Pugging should not be permitted to interfere with ventilation.

Floor coverings of oil-cloth or linoleum should be avoided, especially at first in new houses: where such material is used, a stained border (say, 6" to 9" wide) should invariably be left round the room.

Similar principles to those governing the construction of floors should be observed when putting in panelling and skirtings, especially if a large air space is left at the back of the woodwork.

3. The antiseptic treatment of wood constitutes a third means of protection. Absolute protection can be secured only by thoroughly impregnating timber with an antiseptic, but the cost and difficulty of such treatment are usually too great to render this practicable. Coatings of a suitable antiseptic, however, very greatly decrease the chances of infection of sound wood. Unfortunately no antiseptic is yet known which is perfectly satisfactory in the case of dwelling houses. As a means of guarding against *Merulius lacrymans* the following substances often recommended may be dismissed at once: copper sulphate, iron salts, zinc chloride and mercuric chloride (very poisonous and volatile). Creosote and even tar are effective, but their odour and colour restrict their use. Among inorganic substances boric acid may be recommended. Among organic substances the first place must be given to the di-nitro cresates of potassium or sodium.

Remedial Measures.—Before adopting remedial treatment it is advisable to ascertain the nature of the fungi which are present. They may be practically harmless, *e.g.*, species of *Coprinus*. Even when the woodwork itself is vigorously attacked, however, the measures to be adopted vary with the kind of fungus present. For instance, the rotting of the wood may be due to a fungus which limits its attack to soft woods. In such a case it may suffice to remove the infected pieces and to replace by sound wood, preferably not a "softwood."

Where the presence of a serious attack of dry rot has been established more drastic methods are essential. Not only must the infected wood be removed, but the adjoining woodwork showing no external signs of decay should be tested. In extreme cases it may ultimately involve less loss to destroy the whole building. In less severe

* *See* Journal of the Royal Institute of British Architects, 1910, pp. 220–222.

cases, after the removal of the infected wood, the exposed surfaces (walls, woodwork, and sub-flooring) should be disinfected. A blast flame applied to the brick or stone-work serves to sterilize the surface, and, if applied sufficiently long, will kill parts of the fungus that have penetrated for some distance into the mortar. A wash of dilute formalin, or dilute corrosive sublimate, serves to kill spores and fungus on the surface, but both these substances are useless for prolonged protection of the woodwork as the former evaporates, and the latter volatilizes; of the two formalin is preferable because its vapour has a powerful lethal action on spores. Finally, the wood, especially at the ends, should be coated with the antiseptic selected, which preferably should also be applied to the brickwork and other constructional material. In addition to these measures all practicable steps (proper ventilation, suitable pugging) should be taken to keep the wood as dry as possible.

A fuller account of Dry Rot will be found in the Journal of the Board of Agriculture, Vol. xxiii., August, 1916, pp. 465–474.

London, S.W.1,
June, 1904.
Re-written, August, 1917.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 114.

BOARD OF AGRICULTURE AND FISHERIES.

The Feeding of Poultry.

This Leaflet has been temporarily withdrawn:
see Statement in Prefatory Note.

Leaflet No. 115.

BOARD OF AGRICULTURE AND FISHERIES.

Coral-Spot Disease.

(*Nectria cinnabarina*, Fr.)

One of the most common and most generally distributed of British fungi is that to which the name of Coral-Spot Disease has been given. The first stage of the disease takes the form of bright coral-red warts, which are about the size of millet seed, and are thickly scattered over the surface of dead or dying branches of the tree attacked. These red warts are very conspicuous, and at one time this condition of the fungus was considered to be an independent plant, and was termed *Tubercularia vulgaris*. At this stage numerous and exceedingly minute spores are produced, and readily scattered by the wind or by insects.

At a later stage the coral-red changes to a rusty-brown colour. The surface becomes rough with projecting points, and a second form of fruit is produced. In many instances the fungus passes through all its stages on dead branches, and in such a case no direct injury will be done, but rather a certain amount of good consequent upon the hastened decay of the wood on which the fungus is growing. The indirect danger arising from its presence on dead wood is the possibility of infection of living plants by the spores produced. The earliest indication of disease caused by *Nectria cinnabarina* is the drooping and yellowing of the leaves, which soon die and fall to the ground. In a few weeks the bark becomes slightly shrivelled, and the characteristic coral-red warts appear on the surface. Death of the leaves, and finally of the branch, is due to the choking of the wood vessels by the *mycelium*, which cuts off the supply of water and food.

The fungus is remarkable for the great number of species of woody plants upon which it can grow and produce perfect fruit, being met with on all fruit and forest trees, excepting conifers, and also on various shrubs. Amongst plants especially susceptible to the attacks of *Nectria* may be mentioned sycamore, elm, hazel, apple, pear, and red and black currants.

Preventive Measures.

1. Whenever diseased branches are observed they should be removed and burned without delay, as, after infection, recovery is impossible, and any delay in removal permits the formation of spores and probable infection of neighbouring plants.

2. Fallen branches, stored pea-rods, poles, &c., are often literally covered with the bright coral-pink warts of the *Nectria*, and should then at once be destroyed.

3. When pruning, it is a wise precaution to protect every cut or damaged surface with a coat of gas-tar, and also to remove and trim the ends of branches broken by the wind or by other agency.

Whitehall Place, London, S.W.1,
July, 1904.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

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Leaflet No. 116.

BOARD OF AGRICULTURE AND FISHERIES.

Sleepy Disease of Tomatoes (*Fusarium lycopersici*, Sacc.).

Description, and appearance of Plants attacked.

The "Sleepy-Disease" of tomatoes, although known for some seasons in Great Britain, has acquired an increased importance among growers, owing to the extended cultivation of the plant in recent years.

The plant may be diseased inside when quite young, but the outward manifestations do not necessarily appear at once. The first indication that the tomato is affected is shown in the drooping of the leaves and their bad colour. If the root is split, the woody portion is seen to be of a dingy yellowish brown colour, which becomes more marked if left open for half a day. When the plant has been attacked about three weeks the lower portion of the stem is usually covered with a delicate white bloom of mildew. Eventually the stem is covered with patches of a dull orange colour, and becomes very much decayed. The disease can always be identified by a brownish ring just within the bark at the base of the stem or thicker branches of the root.

The disease is due to a fungus which flourishes in the soil and enters the plant by the root. During its development it passes through three stages, the first of which usually lasts about a week, the stem at the end of that time being much decayed and covered with a gelatinous mass. During the last stage the spores are resting and preparing to attack the young plants another year, or whenever a suitable opportunity presents itself. The plant can only be attacked by the fungus in the last stage of its existence.

Treatment.

1. It must be remembered in the first place that diseased plants never recover, and therefore no attempt to save the plant is successful.

2. As the disease grows inside the plant it is useless to spray with a fungicide.

3. As the resting spores of the fungus live and thrive in the earth and attack the plant through the root the disease must be attacked in that quarter.

It is therefore recommended that :—

1. **All diseased plants should be uprooted immediately the disease is noticed, and should be burned.**

2. The soil in which the plants grew should be removed and sterilised by heat,* or mixed with a liberal allowance of quicklime.

3. If the disease appears in a glass house, every part of the house should be washed with a solution of carbolic acid and water (1 of the acid to 20 parts of water) after the soil has been removed.

4. As much lime as the plants will allow should be mixed with the soil in which tomatoes are grown, more especially if they are grown in the same beds during successive seasons.

5. The infected soil from a bed should not be thrown out at random, but should be sterilised by admixture of quicklime, and care should be taken not to bring it in contact with tomato beds.

6. Only short-jointed sturdy plants should be used, and those should be fairly hard and the foliage of a dark bronze appearance. All spindly or drawn plants should be rejected.

7. The plants should be allowed plenty of air, light, and room for growth.

NOTE.—Other leaflets dealing with diseases of tomatoes are No. 75 (Root-knot Disease in Cucumbers and Tomatoes); No. 152 (Bacterial Disease of Tomatoes); No. 164 (Potato Leaf-Curl and Black Stripe of Tomatoes); No. 225 (The Septoria Disease of Tomatoes); No. 230 (Cucumber and Tomato Canker); No. 242 (Bacteriosis of the Potato and Tomato); and No. 262 (Tomato Leaf Rust).

* See *Journal of Board of Agriculture*, January, 1913, "Partial Sterilisation of Soil for Glass-house Work."

Whitehall Place, London, S.W.1,
November, 1904.
Revised, July, 1913.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

11397 E 2

Leaflet No. 117.

BOARD OF AGRICULTURE AND FISHERIES.

Black-Leg or Potato Stem-Rot.

Description.

This disease, although known for some time on the Continent, has not been prevalent in Great Britain, nor is there reason to think that it is spreading. Where the disease occurs it is very destructive, and the loss caused by it in Germany is frequently 10 to 15 per cent., and sometimes 75 per cent. of the entire crop. In this country it is unknown in an epidemic form.

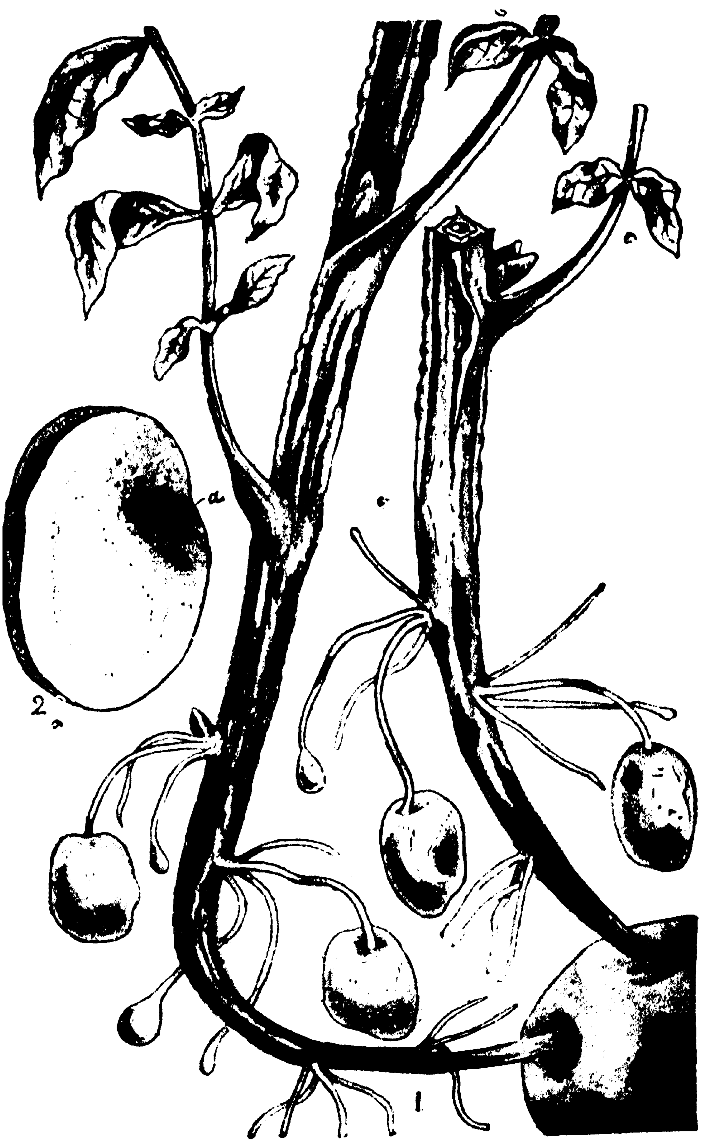
The leading symptoms of the disease are as follows :—The leaves wilt and turn yellow ; then they become shrivelled from below upwards, and finally die. If the underground portion of the stem is examined when the leaves commence to droop, its surface will be found to be more or less covered with brownish stains. This discolouration gradually extends up the stem, which finally becomes black and rotten throughout. The number of plants affected in a potato field varies very widely. Diseased plants may be found growing among perfectly healthy ones, but more frequently the disease spreads from one plant to another.

The disease is primarily caused by a bacterium called *Bacillus phytophthorus*, but as decay proceeds various kinds of fungi, *e.g.*, moulds, &c., assist in the completion of the work. The disease spreads with greatest rapidity during hot, damp weather, and is most abundant during the months of June and July. The death of the haulms at this early period of the season, especially in the case of late varieties, means serious loss, not only on account of the scanty crop, but also because the tubers become infected by the bacteria that have been washed into the soil from the diseased haulms.

Methods of Control.

The following measures have been suggested by Dr. Otto Appel, who has studied the disease in Germany :—

(1.) Potatoes, as well as beans, carrots, turnips, cucumbers, vegetable marrows, sugar-beet, and mangolds, which are also susceptible to the disease, should not be cultivated for two years on land where the disease has occurred. (It has been experimentally proved that cereals are not susceptible.)



Explanation of the Figures.

1. Showing the disease in different stages of development on the haulm.
2. A slightly diseased tuber, the bacteria having entered through minute wound at *a*.

(2.) Potato "sets" should not be cut, but the tubers should be planted entire.

(3.) Care should be taken to obtain seed from districts where the disease does not exist.

(4.) Lime, or strong nitrogenous manures, especially nitrate of soda and sulphate of ammonia, should not be used, but superphosphate of lime may be applied with advantage to land on which a diseased crop has been grown.

Board of Agriculture and Fisheries,
Whitehall Place, S.W.1,
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BOARD OF AGRICULTURE AND FISHERIES.

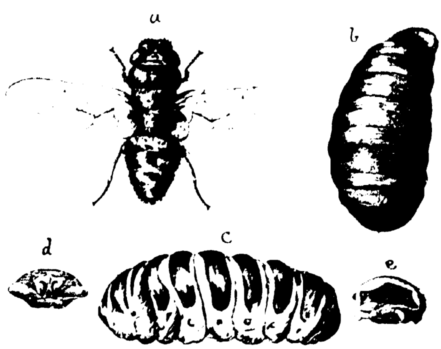
The Sheep Nostril Fly.

The Sheep Nostril Fly (*Oestrus ovis*) belongs to the family Oestridae or Bot Flies. The mouth parts of this species, as of the other bot-flies, are either abortive or rudimentary, so that as adults they do not feed. The harm is done by the larva or maggot which is parasitic on one of the higher vertebrates; in the case of *Oestrus ovis* the sheep is the host.

The Sheep Nostril Fly has a wide distribution, and the harm done by its maggots is known to flock-masters in Britain from north to south.

Description.

The Fly.—The somewhat hairy fly (Fig. *a.*) measures about half an inch in length; the upper surface of the head is light brown, and that of the thorax light brown or yellow to grey. Dark-coloured tubercles are seen on the thorax; the ringed abdomen is brownish yellow with dark spots; and the legs are brown. The wings are glassy, and extend, when the insect is at rest, beyond the body. The balancers (behind the pair of flying wings) are white, and are covered by well marked winglets. These winglets are present at the hinder margin of the flying wings.



THE SHEEP NOSTRIL FLY (*Oestrus ovis*): *a.* Fly; *b.* pupa case; *c.* larva; *d.* head end; *e.* tail end. (*a.*, *b.* and *c.* original and twice natural size; *d.* and *e.* after Ormerod, enlarged.)

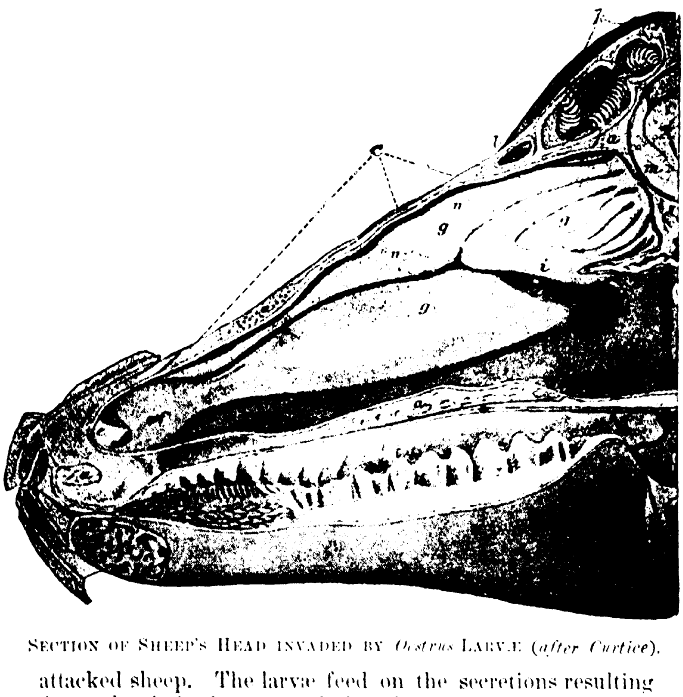
The Egg.—The eggs are somewhat curved or kidney-shaped.

The Larva.—The newly-hatched maggots are at first very small, white, and wormlike, but they become longer and

more rounded at a later stage. They have two hooks directed backwards at the head end, between which is the mouth. Along the under surface of the abdomen are transverse rows of little projections, and on the free end of the last segment are the spiracles or openings of the breathing tubes. Below these is a lobe with spines, and on each side a little process, both of which play their part in the movement of the maggot. The full-grown maggot (Fig. *c*) measures between three-quarters of an inch and an inch.

Life History.

The flies leave their shelter places when the weather is sunny and warm. The sexes pair, and afterwards the females fly towards the sheep. Eggs may be laid round the sheep's nostrils, as seen by Mr. Fred. V. Theobald, or live larvæ may be deposited in the sheep's nostrils. The maggots by their mouth-hooks, anal processes and spines, draw or push themselves up the nostrils (*e*). The pricking and wounding of the lining mucous membrane cause much irritation to the



SECTION OF SHEEP'S HEAD INVADED BY *Œstrus* LARVÆ (*after Curtice*).

attacked sheep. The larvæ feed on the secretions resulting from the irritation caused by their presence and their prickings, and they become mature in the frontal (*k*) and maxillary sinuses of the sheep. Ultimately, the full-grown larvæ return to the passages, and are sneezed out on to the ground. (Occasionally maggots wander into the recesses of

the turbinated bones [*g*, *g*], where they become imprisoned owing to increase in size, and ultimately die.)

The larvæ ejected from the nostrils pass the nymphal stage a little below the surface of the ground, under a clod, or sheltered in a tuft of grass. The fly matures and issues from the puparium during the summer, the complete development requiring about 10 months. The number of maggots in a head varies, but it is usually small. Maggots of very different sizes and in different stages of development may be found in the head at the same time.

The following quotation of Bracy-Clark's, from the Volume of the Linnæan Society's Transactions, for the year 1797, describes the behaviour of sheep when their enemy is at work :—"The moment the fly touches the nose of the sheep they shake their heads and strike the ground violently with their forefeet, at the same time holding their noses close to the earth, they run away, looking about them on every side to see if the fly pursues; they also smell to the grass as they go lest one should be lying in wait for them. If they observe one they gallop back or take some other direction. As they cannot, like the horses, take refuge in the water, they have recourse to a rut, dry dusty road or gravel-pits, where they crowd together during the heat of the day, with their noses held close to the ground, which renders it difficult for the fly to get conveniently at the nostril." On occasion, however, the sheep may remain quite restful.

Symptoms attending infestation.

A discharge, which often agglutinates round the nostrils, is observed. The sheep sneeze in their endeavour to get rid of the larvæ. They toss their heads and rub their noses on the ground or with their feet. Sometimes they walk along with a high stepping gait and with their heads in the air. They may also exhibit difficulty in breathing from the obstruction of the air passages.

There is a loss of condition attendant on the constant irritation.

Treatment.

In combating the sheep nostril fly *prevention* is to be aimed at rather than later remedial measures.

1. Attempts may be made to deter the fly from laying its eggs or maggots by repeated dressings of the nostrils of the sheep, with such materials as tar or fish oil. As this is an onerous task, contrivances are employed for making the sheep dress themselves. These take the form of salting troughs made in the shape of the letter V, the sides of which are smeared with tar, and as the sheep lick the salt they get the tar on their noses. In other cases the boxes containing the salt are closed, save for a hole painted over with tar.

2. Where a pasture is known to be infested the sheep should be removed before the flies issue from the pupa cases.
3. Infested sheep should be isolated so that the maggots when mature may not be sneezed out on to the pasture.
4. To prevent further development the maggots when seen should be destroyed.

Remedial measures are not of much avail, and they may be too troublesome and expensive to be generally practised, save with very valuable prize sheep.

Such measures consist in fumigation to kill the maggots or induce a violent sneezing, which may result in the maggots being ejected. Fluids which, if they reach the maggots, would kill them, may be injected up the nostrils. Cutting into the cavities where the maggots are resident, and picking them out has also been tried with fair success.

Whitehall Place London, S.W.1,
August, 1904.

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BOARD OF AGRICULTURE AND FISHERIES.

Sturdy or Gid in Sheep.

The disease, known commonly under the names of sturdy, gid, turn-sick, &c., is caused by a cyst, or little bladder, called "*Coenurus cerebralis*," which develops in the nerve centres and more particularly in the brain.

The animals which most frequently suffer from it are lambs and shearlings; it is rarer in sheep over two years of age. The disease occurs occasionally in goats, oxen, and other ruminating animals. It is very rarely found in horses. The disease is, however, spread by other animals than these. The tapeworm, which lives in the small intestine of a dog, and is by no means uncommon in sheep dogs and sporting dogs, is the real source of infection.

The tapeworm is made up of a square-shaped head, with a long thin neck and a number of segments. These segments contain eggs, and when ripe they drop off. They are easily seen with the naked eye, being about half an inch long and one-fifth of an inch wide. They may go on increasing in number till the tapeworm is quite forty inches long. They fall off as they become ripe, and are passed through the bowel of the dog to the ground, and it may be on to the pastures where the sheep are feeding. They then decay, and the rain washes the eggs over the grass or into ditches or pools from which animals drink. These eggs die if they cannot get moisture. It is known that a fortnight's exposure in warm dry air will destroy them entirely, whereas even after three months' exposure on damp grass the eggs remain alive, and lambs pastured thereon have caught the disease by browsing the infected grass. This is one reason why sturdy or gid is more common in flocks which feed on damp pastures, especially when the spring and summer have been rainy, but it should be understood that moisture only acts by favouring the preservation of the eggs.

If swallowed by a sheep the eggs hatch out embryos with six hooks, which bore their way through the wall of the stomach or intestines and enter a blood vessel. They are eventually carried in the blood to the brain, spinal cord, and other parts of the body, but they only develop into fully-formed cysts or bladders in the two former. This cyst

gradually increases in size and brings about the symptoms by which the disease is usually recognised.

The cyst, which is the sole cause of "gid," is a little bag of variable size, and though originally very small, may in two or three months become as big as a hen's egg. Its outer coating is very thin, and it is more or less expanded by a clear colourless liquid. The parent cyst develops on its surface 100 to 200 little chambers like white spots about the size of a millet seed, and each contains the head of a future tapeworm. They cannot develop further till the sheep dies, and the brain or the part containing the cyst is eaten by a dog. When this happens each little worm-head is set free from the cyst by the digestive juices. It becomes fixed to the wall of the intestine, and grows for about 2½ months, when the segments are passed out on to the grass in the manner which has already been described.

Symptoms.

A sheep affected with gid may be excitable, and very timid when approached, or it may be dull and stupid. Usually it is seen apart from the rest of the flock walking about unsteadily. Frequently it turns round in a circle. It is seldom at rest for any length of time and if disturbed may try to run away, but it can only move helplessly round in one direction, often with its head carried unevenly on one side. In advanced cases the sheep may become blind.

If the cyst exist in the usual place near the surface of the brain and on one side, the animal usually walks round to that side; if a cyst exists on both sides it may circle to one side or the other at different times; if it be situated in the fore part of the brain, the sheep raises its nose and walks straight forward, only stopping as a rule when it knocks up against something; whilst if the cyst is lodged in the back of the brain, the head is raised and the sheep stumbles forwards with a jerking uncertain motion of its limbs, breaking into a sort of shambling run ending in a fall and a violent struggle to get up. If there be several cysts in various parts, the abnormal movements vary.

In the course of time the affected sheep refuses to eat, and by the combined effects of starvation and almost constant movement it rapidly wastes away and dies. The sheep may live for about six weeks after the appearance of well-marked symptoms.

The cyst may be lodged in the spinal cord, usually at the region of the loins. In this case weakness and drooping of the loins is noticed. Eventually the sheep becomes completely paralysed in its hind quarters, which it cannot raise

from the ground. In such cases the animal may live for months.

Preventive Treatment.

1.—Do not keep more dogs than is necessary to tend the flock. In the spring time of each year, the dogs should be tied up for a few days and treated for worms. The object of tying them up is to see if any tapeworms are passed and if so to collect and complete their destruction by burning.

2.—The heads of sheep which have been affected with "gid" should be burned or boiled, and never left for dogs to eat.

Curative Treatment.

In consequence of the serious nature of the disease, and the frequently unsatisfactory results of treatment, nothing is, as a rule, attempted in the way of a cure, and affected animals are generally sent to the butcher. This is the least expensive course to adopt and usually the most satisfactory. It should be done as soon as distinct symptoms of gid appear, and the butcher should be warned to destroy the heads.

In exceptional circumstances, however, as when the sheep is of considerable individual value, operative treatment may be attempted. The operation consists in piercing the skull, and puncturing the bladder. It is desirable to remove the contents of the bladder, and as much of the latter as possible. Although the operation is sometimes performed with considerable success by intelligent farmers and shepherds, it is, on the whole, of such a delicate nature as to demand the services of a veterinary surgeon.

Whitehall Place, London, S.W.1,
September, 1904.

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Leaflet No. 120.

BOARD OF AGRICULTURE AND FISHERIES.

Peach Leaf-Curl (*Exoascus deformans*).

Distribution, and Plants attacked.

This disease, also known as "curl" or "leaf blister," proves very injurious to peaches and nectarines during certain seasons, whilst almond trees are also sometimes attacked. Occurring in every part of the world where these trees are cultivated, it is most abundant and destructive in humid regions, although not entirely absent from districts where the air is exceptionally dry.

Description, and Appearance of Plants infested.

The leaves and young shoots are the parts attacked by the fungus; on rare occasions the blossom is also infected. Diseased leaves become fleshy, much puckered and twisted or curled, and grow to a larger size than usual; the colour is at first a pale yellowish-green, often becoming more or less tinged with rose colour; finally, the upper surface of diseased leaves becomes covered with a delicate bloom, somewhat resembling that on a plum: this represents the fruit on the fungus. After the fungus has formed fruit, diseased leaves fall to the ground, this usually taking place before midsummer. Young shoots infested by the fungus become swollen and twisted or curved, and the internodes are very short; consequently the diseased leaves usually form a tuft at the end of a stunted shoot. When a branch is once infected, the fungus continues to grow in the tissues, and passes into the new leaf-buds formed each season. The appearance or intensity of the disease, even in the case of leaf-buds originating from infected shoots, depends almost entirely on prevailing climatic conditions. During a genial spring, when growth is unchecked until the leaves are full-grown, "curl" is practically absent; whereas if a cold, damp period occurs while the leaves are young, the disease at once appears, and its rapid spread is much favoured by alternating short spells of warm and cold weather.

Injury caused by the Disease.

The injury caused by the disease consists of the dropping of the fruit at an early stage, and the strain on the tree due to the growth of a second crop of leaves about midsummer, this second crop usually remaining free from disease. In the case of nursery stock, consecutive attacks for three or four seasons usually kill the tree, or stunt its growth to such an extent that it is practically valueless.

PEACH LEAF-CURL.

Sources of Infection and Remedial Measures.

In the United States it is contended that "curl" can held in check by spraying with a fungicide alone; unfor nately, repeated experiments have proved that this is true for this country. In the case of diseased trees, all terminal shoots bearing infected tufts of leaves should removed and burned; diseased fallen leaves should also collected and destroyed. By removing the diseased sho one source of infection, namely, that arising from the spo formed on leaves originating from these diseased shoots, removed; besides, there is no advantage in retaining su contorted twigs on the tree.

A second source of infection depends on the presence spores that have passed the winter in the angle form between leaf-buds and the branch on which they gro inside the bud-scales, or in minute cracks in the bark. Su spores should be destroyed by spraying with Bordea mixture, spraying to commence when the buds show t very first indication of swelling. Two sprayings, at interv of ten days, if thoroughly well done, should suffice. T leaf-buds should not be sprayed after they begin to expan or the foliage will be destroyed or injured.

The mixture should be made with 20 lbs. of sulphate copper and 10 lbs. of lime to 100 gallons of water. T sulphate of copper must be dissolved in a vessel of co water, and the lime, which must be pure and fresh, slak in another vessel. The contents of the two vessels shou be poured together into a tub and the proper quantity water added. Sulphate of copper solutions are poisono and tubs, pails, or other vessels which have contained t mixture must not be used for other purposes.

Whitehall Place, London, S.W.1,
November, 1904.

BOARD OF AGRICULTURE AND FISHERIES.

The Construction of Pigsties.

Contrary to popular opinion, no farm animal is really so clean in its habits as the pig, and probably none suffers so much if obliged to exist in wet, foul, cold surroundings. In the case of all stock, any reasonable expenditure incurred in making them thoroughly comfortable is likely to be well repaid by the better return given for the food consumed, to say nothing of the prevention of those diseases which may arise from bad hygienic conditions.

The pig is an accommodating animal in many respects, but it is not fitted like other farm stock to withstand great changes of temperature, it is very sensitive to damp, and it may be said that pig-keeping is not likely to be a success unless warm, dry, fairly roomy, well ventilated sties are available. It is equally essential that the buildings should be so constructed that they can be easily kept clean, and disinfected from time to time. If these requirements are not satisfied, the most expensive and elaborate building will most certainly give poor results, while on the other hand, so long as these essentials are obtained, there is no reason why good results should not be obtained in the cheapest possible erection.

The common conception of a pigsty is the small low lean-to building opening into an open court. This type of erection has the important advantage of being cheap, but it has serious disadvantages. The only opening into the sty proper is usually so low as to necessitate creeping into it, a fact which militates against frequent cleaning, particularly in wet weather; it is difficult to inspect the pigs except about feeding time ; it is too small and in other ways unsuitable for sows with litters ; the building as commonly constructed is dark, badly ventilated, and owing to the absence of a door is either too cold in winter or too close and hot in summer. Furthermore, if it is not required as a pigsty, it is of little use for anything else, whereas a small building, say 10 feet by 8 feet, about 5 feet high at the eaves, suitably lighted and ventilated, and provided with a door in two sections, would not only be much superior as a pigsty, but would be useful for other purposes, *e.g.*, poultry, storage of fuel, etc., if not required for pigs.

On farms it is doubtful if, in ordinary cases, the erection of the common kind of sty is necessary or justifiable. As a

general rule, all pigs except sows with litters, boars, and those nearly fat can be most economically and advantageously kept in the covered yards with fattening cattle. (It is necessary to say that for the comfort of the cattle the number of pigs should not be too large, and for the sake of the pigs themselves they should have a dry corner fenced off for feeding and sleeping. If the manure from the stables is thrown into the yard, it is important to see that it is well distributed, or the pigs will choose it to sleep in, and "cramp" or "rheumatism" will almost certainly follow.) For young litters, buildings of the loose-box type, opening and draining into the covered yards, or pens cut off from the yards by walls about 5 feet high, are most suitable, and can be used for a great variety of purposes when not employed as pigsties. There is no trouble with drainage or in the disposal of manure, provided the floors are well above the level of the manure in the yards.

Where pigs are kept in large numbers, accommodation such as that suggested is not sufficient, and special piggeries have to be provided. As already mentioned, the essential conditions required by pigs are warmth, dryness, sufficient room, and good sanitation, and so long as these are secured the arrangement and construction of the piggeries can, if desired, be regulated entirely by economy of erection and upkeep, and of labour involved in feeding and tending the pigs.

There are, however, certain essential conditions which should be secured in whatever kind of building is erected.

Situation and Aspect.—If at all possible, a fairly high and dry position should be selected, and in no case should the level of the floor be below the level of the surrounding ground, since buildings so constructed are almost certain to be damp and cold. The doorways, courts, windows, and openings should as far as possible be on the south side. Sties facing north may in some cases be unavoidable, but should never be used for young pigs, except possibly during the hot summer months.

Sties for boars, especially sties used for boars to which sows from other premises are sent for service, should be isolated from the sties in which other pigs are kept.

Floor.—This is in many respects the most important part of the building, and the part in which it is most difficult to combine conditions which are desirable from all points of view. For instance, for cleanliness, durability and cheapness there is no doubt whatever that a floor of concrete with a skin of smooth cement is the best. Such floors are, however, unsuitable for, at any rate, the sleeping quarters of pigs; they are always cold, and young pigs reared in houses with cement floors generally do badly, even if they do not develop

cramp or rheumatism. Furthermore, if even slightly dirty they are as a rule very slippery. A compromise often made, is to have a cement floor, but to provide a movable wooden platform for the pigs to lie on, and this is good if the sty is roomy enough to allow of the platform being lifted frequently for cleaning purposes. Otherwise, dirt and manure will accumulate underneath. Probably a better plan is to have at least part of the floor laid with asphalt, or to make it of bricks set on edge in cement on a bed of concrete. Such floors are warmer than cement, give a much better foothold, and are fairly easily kept clean, though a slightly greater slope is required for efficient drainage.

Walls.—The walls must be weather proof, substantial and easily kept clean, and may be made of brick, concrete, or stone. Wooden walls can only be regarded as a makeshift, since with them it is impossible entirely to avoid cracks or joints in which manure lodges, while the junction with the floor is always a source of trouble, and unless protected by sheet iron or some such material, the lower part of the wall is gradually gnawed away by the occupants of the sty. If the wall is made of brick or stone, all joints should be smoothly pointed with cement, or, better still, the wall should be faced with cement to a height of at least 3 feet from the floor. When the sty is intended for breeding-sows, a rail, which is best made of iron tubing about an inch and a half in diameter, should be fixed about 10 inches from the floor, and the same distance from the walls, to protect the young from being crushed. Partition walls need not be more than about 4 feet high, though in the case of a long building some should be taken up to the roof. In the case of extensive piggeries it is convenient to have some of the partitions so constructed that if required two or more sties can be thrown into one.

Roof.—The roof should be weather-proof and non-conducting, and may suitably be tiled, or boarded and covered with galvanized sheeting or thoroughly tarred felt.

In the case of lean-to sties, the roof should be not less than 4 feet 6 inches above the floor in its lowest part, and about 7 feet at the back. This is necessary in order to allow the sty to be thoroughly cleaned, and also to enable the animals to be examined and tended in case of sickness. It also ensures sufficient airspace and facilitates proper ventilation.

Airspace and Ventilation.—The airspace should not be so large that the buildings are cold, nor yet so small that, in order to secure efficient ventilation, draughts are unavoidable, Ventilation should be secured by openings in the wall and roof. Lighting, which is most easily done by panes of glass in the roof, should be sufficient. In order to avoid scorching

of the pigs the glass should be roughened and thick. Sunlight is a cheap and good disinfectant, apart from its direct effect on the health of animals.

Drainage.—Drainage is a most important point. It may be laid down as a general rule that there should on no account be a closed drain in any sty, and furthermore the drainage from each sty should be conducted separately to a main drain outside. The plan of draining a row of sties by one channel which passes through each in turn should never be adopted ; the last one is apt to be wet and unhealthy, and if disease—*e.g.*, husk—breaks out in any sty, all the pigs below it are likely to become infected by means of the drain.

Troughs.—The simplest and best trough is made of glazed fireclay, semicircular in section, and set in concrete. It should be set in the centre of a partition which, immediately above the trough, should consist of a hanging door supported on an iron rail. When hanging freely, this door is immediately over the centre of the trough, but it may be pushed inwards, thus completely shutting off the trough from the sty, or it may be pulled outwards, leaving the trough open to the pigs. The advantages of the system are obvious : the pigs can be fed, or the trough cleaned out, without the attendant entering the sty, while there is no chute where food is apt to lodge.

Courts and Runs.—Whether separate courts for the sties are provided or not an extensive outdoor run is essential for sows and young pigs, and if possible a dry sunny paddock should be provided for the purpose.

Whitehall Place, London, S.W.1,
Re-written, June, 1912.

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BOARD OF AGRICULTURE AND FISHERIES.

The Cabbage Root Fly (*Chortophila brassicæ*).

Fig. 1.

Fig. 2.

Fig. 3.

Fig. 4.

Fig. 1. Male Fly, greatly magnified. Fig. 2. Maggot, magnified. Fig. 3. Last segment of maggot enlarged, showing tubercles. Fig. 4. Puparium, magnified.

(Figs. 1 and 3 after Prof. M. V. Slingerland.)

This little fly is a troublesome pest on cabbages and allied crops, in Great Britain and other European countries, and also in the United States and Canada. It belongs to the family *Anthomyidæ*, a very large family of flies the members of which may easily be mistaken for ordinary house flies. There is a great deal of confusion as to the identity of this species, and the attacks of other root-eating maggots have been attributed to it.

Plants attacked.

When a plant is attacked, growth is checked, the leaves discolour and wither, the infested parts become slimy, rotting takes place, and eventually the plant often dies.

The cabbage fly is mainly an enemy to plants belonging to the cabbage and turnip family, although there is an American record of the maggots mining the leaves of beet. The maggot has been found at work on the cauliflower, turnip and swede ; cauliflowers have been attacked, while Brussels-sprouts grown alongside and planted at the same time were unharmed. Attacks have also been recorded on broccoli, the radish, and the garden stock, as well as on such common

weeds as shepherd's purse, winter cress or yellow rocket, and hedge mustard.

Description.

The adult flies are about ¼ in. in length. They are ashy grey or brownish grey in colour and in general appearance much resemble a house fly.

The egg is very small but visible to the naked eye, whitish in colour, and narrow oval in shape.

The larva or maggot is white or whitish-yellow and legless; the head end is pointed, and has two dark curved mouth hooks; the hind end is cut short abruptly, and the last

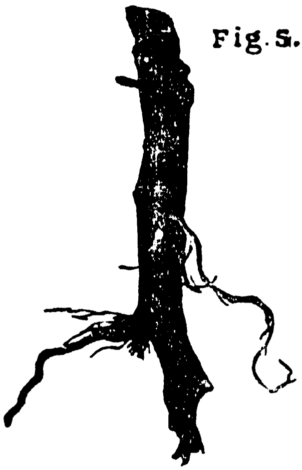

Fig. 5.

Fig. 6

Fig. 5. Part of attacked cabbage, with larva *in situ*.
Fig. 6. Withered leaves of attacked cabbage.

segment carries on its middle two dark breathing pores. All round the edge of this last segment are 12 little projections, which can be seen on examination with a good lens, the two lowest being larger, and forked, the latter peculiarity being characteristic of the species. When full grown the maggot measures ¼ in.; it becomes a pupa under cover of its last moulted skin.

The puparium or pupa-case is light or dark brown in colour and oval in shape.

Life History.

The females lay their eggs close to the plant, choosing, it may be, a crack in the soil by which they can get below the surface, so that the eggs may be laid as near the plant as

possible. In a week or more, according to weather conditions, the eggs are hatched, and the maggots first of all gnaw the external layers of the young roots, and then make and occupy galleries in the skin of the main root. Sometimes the lower part of the stem is invaded, in which case the pith is tunnelled. In Scotland the maggots have been found tunnelling in the leaf stalks of the swede. When full grown the larvæ pass into the soil a little away from the attacked plant, and become pupæ. Pupation may also take place in the infested plant. The first flies of the year appear for their egg-laying towards the end of April and in May, and there are probably three generations in the year.

Methods of Control.

1. Very early sown plants are noticed largely to escape, possibly on account of the lower temperature. Early setting out, however, is not always practicable, and even early planted cabbages may not escape attack altogether.

2. Protecting the cabbages and cauliflowers by means of paper or cards is a preventive measure which has met with success in American and Canadian experiments. In one experiment 72 per cent. of the protected plants matured as compared with only 19 per cent. on the untreated or control plot. The total cost worked out at about 6s. per 1,000 plants The flies are not able to get near enough to the protected plants for their egg-laying; presumably maggots from any eggs laid beyond the extent of the card are unable to reach the plants. The cards are cut from roofing paper known as single-ply tarred felt. They are six-sided, about three inches across, with a slit reaching to the centre where there is a star-shaped cut to fit closely round any thickness of stem. The cards should be placed round the plants at the time of transplanting or setting out. To place the card in position, bend it slightly to open the slit, then slip it on to the centre, the stem entering the slit, after which spread the card out flat and press the points, formed by the star-shaped cut, round the stem. The card must be put on carefully and lie close to the ground, so as to prevent the fly from creeping under to lay her eggs.

3. Badly infested plants, including the stumps, should be removed and burned.

4. Carbolic acid emulsion has also been used in America for destroying the eggs, or for killing the maggots, but the results have not been uniformly satisfactory. The formula for the carbolic acid emulsion is 1 lb. of hard soap or 1 qt. of soft soap, dissolved in 1 gall. of boiling water, into which 1 pint of crude carbolic acid is poured. This should be well stirred till an emulsion is formed. For use, one part of the emulsion should be diluted with thirty-five to forty equal

parts of water. This solution may be applied with a can or spraying machine from which the nozzle has been removed, so as to saturate the soil nearest the roots of the plants.

5. Bulletin No. 12 of the Canadian Department of Agriculture (1916) states that some success has been obtained in the case of garden crops by means of decoctions of hellebore or pyrethrum. Two oz. of either of these insecticides are mixed with 1 gall. of water and the liquid is watered round the plants in the same manner as carbolic emulsion. In the case of hellebore it is stated that the powder should first be steeped in a little warm water and then be diluted to 1 gall. to obtain a good mixture. Three waterings are given at intervals of a week, and it appears that the best results are obtained when the surface soil is scraped away from the stems so that the liquid may penetrate to the roots.

6. Where the attack has been bad, neither cabbages nor any other cruciferous crop should immediately follow and all cruciferous weeds, which may serve as host plants for the cabbage maggot, should be destroyed.

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Leaflet No. 123.

BOARD OF AGRICULTURE AND FISHERIES.

The Shoot and Fruit Moth of Red and Black Currants.

Incurvaria capitella, Fab. = *Tinea capitella*, Cl.

Moth and Caterpillar (both magnified).

This little moth, which is not far removed in relationship from the Raspberry Moth (*Lampronia rubiella*), is one of a section of tiny moths, the members of which show considerable variations in life-history. The caterpillars of some species feed on the outside of leaves, others mine into leaves, while others feed at various stages of their life on quite different portions of the plant they attack. The caterpillars of *Incurvaria capitella* behave in the last-mentioned way, feeding in the young stage in the currant fruits, and completing their growth in the buds and young shoots. Attacks are chiefly recorded upon Red Currant, but in 1896 Miss Ormerod chronicled an attack on the Black Currant. The presence of the pest is revealed by the flower buds failing to develop, while young shoots droop, wither, and eventually die.

Description.

Moth.—The moth measures about half an inch in length, and over half an inch in spread of fore-wings. The head is deep yellow in colour; the fore-wings dark brown with a slight purple tinge. Less than half way from the base of each fore-wing is a pale yellow band running from the hind margin to the front margin; nearer the outside border on each fore-wing are two light yellow spots. The hind-wings are purple grey, while these and the outer margins of the fore-wings are ciliated, or very finely divided.

The moth has been found in North Ireland, and in England as far north as York and Manchester.

Caterpillar.—The young caterpillar on issuing from the currant fruit previous to its hibernating or resting state is extremely small (one-twelfth of an inch); it is reddish or greenish yellow in colour and has the characteristic 16 legs of a moth caterpillar; the four pairs of abdominal or middle legs are without hooks. The grown caterpillar—found in the buds and shoots—has hooks on the abdominal legs. The head is dark and the next segment has a dark plate, and there are hairs on the head and the various segments.

Shoot tunnelled by Caterpillar to the right, and Caterpillar in bored shoot to the left.

Life-history.

We owe our knowledge of the stages from the adult moth to the appearance of the caterpillar in the shoots to Dr. A. T. Chapman. The moths may be found in May flying in the neighbourhood of the currant bushes. The females lay their whitish lemon-shaped eggs in the young currant fruit. The mode of egg-laying is interesting. The moth chooses a currant and, resting on it, inserts her long ovipositor, or egg-lying tube, into the pulp and deposits the eggs near the seeds. Dr. Chapman believes two eggs to be left behind at each penetration of the currant by the ovipositor and thus more than one caterpillar may be found in a single fruit. The caterpillars on hatching feed on the seed. After feeding for a time, the caterpillar, though still very small and far from having completed its growth, burrows out of the fruit in June or July and spins a white case which is attached to the old persistent bud-scales or to the bark. With this protection the caterpillar enters upon a resting period which lasts into the next spring, when the partly grown larva leaves its case and bores into the buds, and also tunnels the young shoots. Here it renews its feeding and in April or the beginning of May completes its growth. The full grown caterpillar now passes into the chrysalis condition, and later the moth issues from the cocoon to proceed to pairing and egg-laying.

Preventive and Remedial Measures.

1. In order to destroy the caterpillars sheltering in their cases spraying should be done in winter with the emulsion-soda wash as recommended in Leaflet No. 70 (*Treatment of Neglected Orchards*).

In connection with this Woburn soda-emulsion wash it has been found advantageous to make the emulsion with sulphate of iron and lime rather than with soap. The formula would then be :—Sulphate of iron, ½ lb.; lime, ¼ lb.; paraffin (solar distillate), 5 pints; caustic soda, 2 lb.; water to make 10 gallons. In order to prepare this wash the following rules should be observed :—(*a*) Dissolve the iron sulphate in about 9 gallons of water; (*b*) slake the lime in a little water and then add a little more water to make it into a "milk"; (*c*) run *b* into *a* through a piece of coarse sacking to keep back grit; (*d*) churn the paraffin into the mixture; and (*e*) add the caustic soda in the powdered condition just before using the wash.

2. Handpicking and burning the infested drooping shoots before the pests have escaped should be practised as a preventive against future infestation.

3. The Blue Tit has been observed feeding on the hibernating larvae. For an account of the Blue Tit see Leaflet No. 43 (*Titmice*).

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Leaflet No. 124.

BOARD OF AGRICULTURE AND FISHERIES.

The Asparagus Fly, *Platyparea poeciloptera* (*Ortalis fulminans*).

a. Male. *b.* Female, both magnified (after Taschenberg)

This fly belongs to a family, some of the mature members of which have, as a characteristic, beautifully banded wings, whilst the maggots or larvæ have a boring habit.

Description.

Imago.—The Asparagus Fly is a small fly—the lines in the figure represent its actual length and spread of wings—with brown as the prevailing colour. The thorax, head, and legs are glossy brown, and the antennæ and face yellow-brown; the abdomen is brown-black, and shows at its hinder end four rather light transverse lines. The two wings, somewhat rounded at their ends, are marked by brownish zig-zag stripes. The body of the female is pointed and bears a well-marked ovipositor, whilst the end of the male is rounded. Both male and female are hairy.

Larva.—The larva is a roundish, glossy, and legless maggot, which is yellowish in colour; at the dark head end are two easily distinguishable gnawing mouth hooks; at the hind end, which is somewhat flattened, is a black-brown plate, to which are attached two hook-shaped or anchor-like processes. Full grown the maggot measures about half an inch.

Pupa.—The pupa is barrel-shaped; at first it is light yellowish-brown in colour, but later it becomes darker, and is slightly flatter on the under surface than on the upper; a short anchor-like double hook is at the hind end.

Life History.

The flies, issuing from early in April onwards until about the middle of July, lay their eggs beneath the scales of the

asparagus heads as these are appearing through the soil, or in the neighbourhood of the leaves on the already tall stems which are even approaching flowering.

In a few days—a fortnight to three weeks according to some authorities—the larvæ hatch out, and boring into the tender stalks and young shoots, feed in a downward course. The maggots working downwards, follow the longitudinal axis of the stem, their presence being marked by yellowish galleries or tunnels; these last are often too deep-seated to be seen without dissection. Pupation takes place from June onwards, according to the time of egg-laying, but is practically over by August. It is considered probable that there may be two generations in the year. The pupæ hibernate in the underground portion of the stem, often many together.

Symptoms and result of attack.

The affected shoots become brownish or yellow in colour and are stunted and decomposed, rotting finally below the ground, or at the point where they emerge from the soil. The affected stems occasionally show a bluish colour.

Treatment.

1. Where the area to be treated is small and easily examined, good results may follow if small rods, dipped in a sticky substance, are stuck in the ground early in spring. The flies will settle on these and be caught.
2. Collect the flies early in the morning when they are resting on the tops of the asparagus shoots.
3. Taschenberg recommends sprinkling the tops of the shoots, when the dew is on them, with powdered charcoal; this discourages the flies at the time of egg-laying.
4. During the summer all injured stems should be cut away with the asparagus knife and burned.
5. In autumn all remaining stem parts showing larval tunnels, and all dry stumps, should be deeply dug up and burned, so that injury in the next year may be lessened or prevented by the destruction of the pupæ.

Whitehall Place, London, S.W.1,

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Leaflet No. 125.

BOARD OF AGRICULTURE AND FISHERIES.

The Hessian Fly (*Cecidomyia destructor*).

Plants Attacked.

Wheat, Barley and Rye are the favourite food-plants of the Hessian Fly. There are also records of infestation on Timothy Grass and Couch Grass in Russia.

Description.

Adult.—The fly measures one-tenth of an inch in length. It is dark-coloured, with the abdomen reddish in fresh specimens; the wings are black or smoky-grey, due to their covering of hairs or scales; and the balancers are yellow-brown with black scales. The antennæ are long and many-jointed, with a whorl of fine hairs at each joint, and there are black scales on the long and slender legs. The male is somewhat smaller and more slender than the female and the slightly longer antennæ have the hairs more marked.

Egg.—The egg is glossy, and reddish in colour; it is one-fiftieth of an inch in length.

Larva.—The larva is a legless maggot, having thirteen segments including the head, and tapering somewhat both in front and behind. It is yellowish-white, with slight differences in colour and external appearance according to the stage of growth.

Puparium and Pupa.—The puparium, or pupa-case in which the pupa is enclosed, is the last moulted skin of the full-grown maggot; it is brown in colour and resembles a flax-seed in shape and size. The pupa, which is whitish, has a very delicate investing membrane.

Life History.

The eggs are laid, in May and June, in the furrows on the upper surface of the young leaves of the cereal; and a number of eggs may be laid on the same leaf. The maggots, which hatch in a few days, move from the place of hatching to their feeding place between the leaf-sheath and the stem of the plant; a favourite position being just above the second or the first joint or knot, on the stem. The infested plants become weakened by the loss of sap; and the affected crop may appear to have been severely weather-beaten, the stems becoming "elbowed," and bending over just above the place where the maggots are located. The length of the larval stage varies with the climatic conditions from less to more than a month. The full-grown maggot pupates at the place of feeding. The number of possible generations in the year varies with climatic and other conditions. There may possibly

be an issue of adult flies from the pupæ in the same year in Great Britain, but the issue to be feared is the one which causes the attack in the next year, at the end of April or in May.

Treatment.

1. When the crop is harvested many of the "flax seeds" or pupa-cases will be left in the stubble owing to the position of the infestation low down in the stem. The stubble should, therefore, whenever practicable, be burnt, or so deeply ploughed under that flies from the buried pupa-cases will be unable to reach the surface. All screenings and "flax seeds" that fall away in thrashing should be burnt.

2. The grain from an infested crop should not be used for seed. The value of the grain depends to a large extent on the reserve material stored up by the seed during the process of ripening, and plants stunted and weakened by attack will naturally produce poorer seed.

3. Fertilisers, especially in the case of a mild infestation, would prove useful in aiding the plant to tide over attack. Stout, coarse-stemmed varieties of wheat and barley should be grown, as they are less likely to "elbow."

4. Clover following a cereal crop is quite safe, as the Hessian fly does not attack clover, but flies from the "flax seeds" in the stubble may pass in a favourable season the following year to other cereal plants; in order to prevent such a contingency, the cereal crop might be sown without "seeds" so that the stubble could be ploughed in, or burnt, as suggested above.

5. Winter wheat should be sown as late as practicable, in order to avoid a possible attack by flies that may issue in the autumn.

6. The Hessian Fly maggot is preyed on by a number of parasites belonging to the Ichneumonidæ, a family of Hymenopterous insects.

Although this fly is occasionally met with, it has not in recent years been the cause of any very serious damage, but in 1886 and 1887 the insect became somewhat widely distributed throughout Great Britain, twenty counties in England and ten in Scotland being affected.

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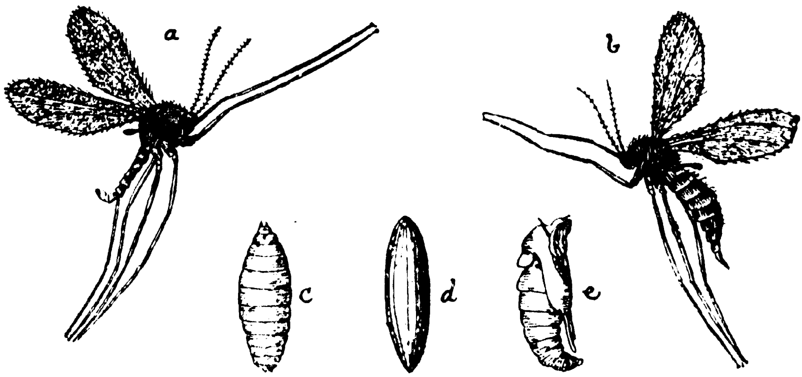
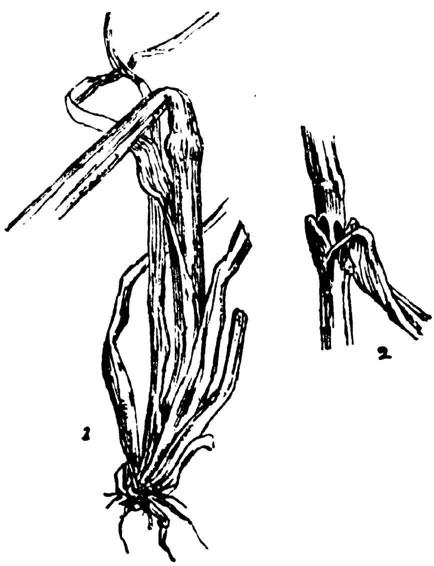


HESSIAN FLY.—*a.* Male ; *b.* Female ; *c.* Larva ; *d.* Puparium ; *e.* Pupa. All much magnified. (*b.* after Ormerod.)

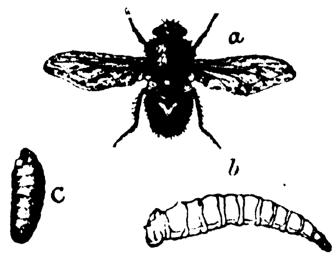


1. Barley stem "elbowed" by Hessian Fly larvae. 2. Showing position of puparia, or so-called "flax-seeds" (after Ormerod).

Leaflet No. 126.

BOARD OF AGRICULTURE AND FISHERIES.

The Sheep Maggot Fly (*Lucilia sericata*).



a. Fly; *b.* Maggot; *c.* Pupa Case Showing Place of Exit of Fly. (All twice natural size.)

Green-bottles (*Lucilia*) and Blue-bottles (*Calliphora*) are two genera belonging to the *Muscidae*, an important family of the two-winged flies. One of the green-bottle flies (*Lucilia sericata*) is a very prevalent cause of maggots on sheep, which, when attacked, show the following symptoms :—

(1.) Matting together of the wool fibres.

(2.) A continual wagging of the tail.

(3.) Rubbing and biting by the sheep in their efforts to allay the irritation caused by the maggots.

(4.) Much inflammation.

(5.) Oozing from the sores of an evil-smelling sticky fluid.

(6.) Discolouration of the wool, which falls out, and in bad cases does not grow again.

(7.) Rapid loss of condition.

Description of Lucilia in its different stages.

L. sericata is a bright shining green or blue-green fly, about one-third of an inch long, and about seven-eighths of an inch in spread of wing. The fly, examined with a lens, is seen to be covered with dark bristles, the arrangement of these bristles being used as an aid in distinguishing this and allied species.

The *eggs* are yellowish-white and measure about one-sixteenth of an inch in length.

The *larva* is a legless maggot, capable, however, of an active crawling movement. It measures, when full-grown, up to half an inch or more in length; the head end is pointed and provided with two mouth hooks; the hind end is blunt with tubercles round its margin and two plates carrying the spiracles on its flat surface. Examination, with a good lens, of the first segment behind the head, shows the spiracle to be fan-shaped and to bear ten little prominences. Professor Carpenter points out that a blue-bottle maggot would show in the same situation 13 such prominences.

The *pupa-cases* are brown and rounded or barrel-shaped, and the fly when ready issues by a hole at one end.

Life History.

The female fly is capable of laying as many as 500 eggs, and fixes these to the wool in clusters of 20 or more. These eggs may hatch in 24 hours, the resulting maggots feeding at first externally and later boring into the skin and flesh. In a fortnight they may be full grown, when they drop away from the sheep and become pupae under cover of the barrel-shaped cases. In certain experiments which have been carried out the flies issued in from less than a fortnight to over a fortnight, according to temperature and other conditions.

An attack is worse on lambs than on old sheep and the flies are found at work from May onwards until the autumn. Moist, warm, muggy weather, or warm sunshine after showers favours the fly.

Loss.

Direct loss by death is infrequent where careful oversight by the shepherds is possible, such loss being most likely on hill pastures. Unfortunately, for some reason, maggots are now found at much higher elevations than formerly. Indirect loss is heavy owing to the disturbance to the flock caused by the frequent hunting and collecting. "Struck" sheep also thrive badly and are depreciated in value partly from this and partly on account of disfiguration.

Preventive Measures.

(1.) *Cleanliness.*—Sheep should be kept thoroughly clean about their hind quarters. A good measure is to clip the wool of the tail and between the hind legs. The purpose is to clear away any filth and to give as little opportunity as possible for lodgment, for the flies have a keen sense of smell

and are attracted to dirty places for their egg laying. Hence it is that sheep suffering from diarrhœa fall such easy prey to the fly.

(2.) *Destruction of Carcases.*—Carcases of all dead animals, including birds, should be burned or buried so that they may not serve as breeding places for the fly.

(3.) *Dipping.*—As a preventive measure dipping is useful, but as immunity does not last beyond a fortnight or so the dipping must be repeated. Sulphur is regarded as an indispensable ingredient in any such treatment, the odour keeping away the fly. Carbolic dips are valueless for this purpose.

(4.) *Dressing.*—Dress the neighbourhood of wounds with some deterrent dressing, *e.g.*, an ointment of butter and flowers of sulphur, or spirits of tar.

Remedial Measures.

(a.) Infested sheep should be isolated.

(b.) The maggots are not difficult to kill. They should be picked or rubbed off, or where they have got to work the wool may be shorn a little, the affected parts being dressed with a mixture of turpentine and rape oil in equal parts, or with dilute paraffin oil, finishing off with a dusting of sulphur.

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Leaflet No. 127.

BOARD OF AGRICULTURE AND FISHERIES.

The Stalk (Sclerotinia) Disease of Potatoes and related Sclerotinia Diseases (*Sclerotinia sclerotiorum*, Bref.).

The diseases dealt with in this leaflet are caused by the fungus *Sclerotinia sclerotiorum*, Bref., a parasite well known both in Europe and America, and capable of attacking a wide range of cultivated plants, both annual and herbaceous. The method of infection and behaviour of the fungus have been most carefully studied in the case of the potato and, as the life-history of the parasite and the treatment to be adopted are the same when other crops are concerned, the potato disease only is described in detail.

S. sclerotiorum is allied to *S. trifoliorum*, one of the fungi associated with clover sickness and described in Leaflet No. 271, and also to *S. bulborum*, a fungus which attacks various bulbous plants in gardens.

The stalk disease of potatoes is most destructive in the northern and damper parts of the country. In the west of Ireland the loss occasioned by it is so great that, with the exception of the ordinary potato blight (*Phytophthora infestans*), it is stated to be the most serious disease with which growers have to contend. The fungus attacks the stem, either near the ground or at some distance above it. Subsequently it penetrates the inner tissues and destroys them so that the stem falls over at the affected spot and dies. Though the tubers are not attacked the yield is reduced owing to the death of the shoot, and in districts where *Sclerotinia* is widespread the crop may suffer very severely.

Description and Life-History.

In the earliest phases of attack, usually about the beginning of July, the disease shows itself in the form of white patches of fungus threads or *mycelium*, on the outside of the stem (Fig. 1).* In contrast to most stem diseases there is little yellowing of the foliage, with the result that infected plants are easily overlooked. If dull, damp weather prevails the mycelium develops rapidly and begins to form oval or spherical cushions, white in colour, and from which minute drops of water exude (Fig. 2). These cushions represent

* For the illustrations used in this Leaflet the Board are indebted to the Department of Agriculture and Technical Instruction for Ireland.

the youngest stages of the resting bodies known as *sclerotia*. The sclerotia consist of a compact mass of mycelium, which later becomes firm and finally hard and black, though internally it remains white. They are spherical or oval in shape, and usually about the size of a pea, but frequently much elongated. When ripe they fall off and remain dormant in the soil until the following spring. It is owing to the presence of these sclerotia that the fungus derives its generic name *Sclerotinia*, though it should be remembered that sclerotia are also produced by many other fungi.

In addition to forming external mycelium and sclerotia the fungus gradually penetrates the inner tissues of the stem. The cells are invaded, and the pith-cavity is filled up with fluffy white mycelium in which sclerotia, similar to those produced externally, develop (Fig. 3). The latter remain inside the stems, but ultimately reach the soil if the stems are allowed to decay on the land. The result of this internal development of mycelium is the blocking up of the water-conducting channels. At the point of attack the tissues are killed and the stem bends over, and sooner or later dies.

The fate of the sclerotia in the soil has been carefully studied by several observers. They remain dormant until early summer, when they germinate and give rise to small disc- or cup-shaped bodies which produce the spores (Fig. 4). The cups are borne on slender stalks, and appear just above the surface of the soil. They are pale, brownish yellow in colour and from one-quarter to one-half an inch in diameter. These disc-shaped cups which form a characteristic feature of the very large group of fungi known as *Discomycetes* are termed *apothecia*. When ripe the apothecia discharge their spores into the air, usually in large numbers at a time. If the apothecia are carefully watched, smoke-like puffs of spores may be seen arising from them. The intermittent discharge of spores from a single cup may continue for two or three weeks.

It was previously thought that potato plants were infected by vegetative mycelium present in the soil, but recent investigations carried out in Ireland have shown that this is not the case, but that infection is brought about exclusively by air-borne spores derived from the apothecia. The spores are blown across the fields and alight on the foliage. On germination they are capable of infecting the older and fading leaves, and from the leaf the fungus passes into the stem. In some cases direct infection of healthy tissues apparently also takes place, especially in parts of the plant such as leaf axils where moisture is preserved.

S. sclerotiorum possesses no conidial form of reproduction. The *Botrytis* found on potato haulms, and formerly thought to be a stage in the life cycle, is now known to be an entirely

distinct fungus.* In winter, Sclerotinia is perpetuated by the hard, black sclerotia in the soil, and in early summer it is propagated by means of the spores liberated from the cup-shaped apothecia.

Infection of other Crops.

As mentioned above many other cultivated plants, of which the following are amongst the most important, are attacked by *S. sclerotiorum* :— Tomato, artichoke, sunflower, bean, marrow, cucumber, carrot, and turnip. Though the fungus-attack has not been carefully studied in the case of most of these plants, it is safe to assume that infection takes place by means of spores or by mycelium derived from a spore, though infection by mycelium produced from sclerotia may, perhaps, also take place. In most cases spore-infection probably occurs, as in the potato, through old leaves or wounded surfaces, though under conditions of exceptional moisture direct infection of healthy tissue also may be expected. In all cases sclerotia are produced in abundance. These fall to the ground or remain in the dead tissues of the plant, where they lie dormant till the spring, when they germinate or form spore-cups in the usual way. Disease seldom appears before midsummer, and is favoured by warm damp weather.

Treatment.

(1.) The most important measure to adopt is systematically to collect and burn all diseased portions of the plant in order to prevent the sclerotia from reaching the soil. If this is carried out thoroughly, the number of spore-bearing cups produced in spring will be largely reduced.

(2.) Applications of lime and spraying with fungicides have not yielded satisfactory results.

(3.) For greenhouse or garden work sterilisation of the soil by steam may be recommended.

(4.) Unless the soil has been sterilized, plants liable to be attacked by Sclerotinia should not be grown for at least three years in infected soil. The fresh site selected should be well removed from the old one.

* The fact that both these fungi produce sclerotia, and that frequently they both occur on the same plant, has been the cause of much confusion in the past. In *Botrytis* the sclerotia are small and wrinkled and are almost always flattened. They remain attached to the potato stems and on germination give rise to the mould stage of *Botrytis cinerea*. In *S. sclerotiorum* the sclerotia are much larger and rounded in form. Microscopically, also, they show a slightly different structure. They easily fall from the plant and produce on germination the small cup-shaped apothecia. *Botrytis cinerea* is much more common than *S. sclerotiorum*. For Botrytis diseases, *see* Leaflet No. 234.

FIG. 1.—STALK DISEASE. A stalk attacked in two places, at one of which fracture has occurred.

FIG. 2.—STALK DISEASE. The white bodies on the surface of the stalks are immature sclerotia.

No. 127.

FIG. 4.—STALK DISEASE. A single sclerotium which, after lying dormant during winter, has produced a spore-bearing cup or apothecium (nat. size).

(5.) In the case of potatoes, in the west of Ireland, late planting has proved successful, the explanation being that fewer old leaves (which provide the fungus with an easy means of entry) are available at the time of the main spore-discharge.

(6.) When root crops are concerned, the greatest care should be exercised as to storage, and all diseased or damaged roots should be rejected.

Whitehall Place, London S.W.1,
January, 1905.
Re-written, March 1917.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

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Leaflet No. 128.

BOARD OF AGRICULTURE AND FISHERIES.

Advice to Beginners in Bee-keeping.

The keeping of bees is much more common now than forty years ago, when the fall in the price of sugar had nearly driven from the country markets the coarse honey gathered by the old straw skep system. This increase of bee-keeping has been chiefly brought about by the perfecting of the modern frame-hive, which enables the home of the bee to be laid open to view, and allows of the stores being taken, fit for immediate use, without injury to the bees or their owner. Within the last few years, however, the prevalence of Isle of Wight disease has led many bee-keepers to abandon the pursuit.

First Steps.

One of the first steps to be taken by those desirous of becoming bee-keepers is to obtain a good book on apiculture, and to study it carefully. There are many books from which a choice may be made. It would also be advisable to join a County Bee-Keepers' Association, as in this way much advice and information can be obtained, whilst Secretaries of such societies will be able to furnish names of expert bee-keepers willing to render assistance if needed.

A personal explanation of the terms used and of the outfit required is a great help, and an interview for that purpose should, if possible, be obtained with an experienced bee-keeper.

Appliances.

The appliances required are: Black net veil; smoker, for subduing bees; wax comb foundation (brood and super); bottle-feeder; section boxes; and a frame-hive, fitted with brood-foundation in ten or twelve standard frames, two division boards, section-rack or lift of shallow frames, a queen excluder and quilts. If the hive is to be worked for extracted honey, a centrifugal honey-extractor will also be needed.

Additional useful articles are: Scraper-knife, for cleaning floor-boards, frames, &c.; comb-uncapping knife, for use when extracting; a straw skep, for taking swarms; spare coverings of felt or carpet; and a super-clearer, for clearing bees from section racks or supers.

The Hive.

There are many patterns of hives, all made to take the one British Standard frame. A simple one should be chosen possessing accuracy of workmanship and soundness of material, so as to stand exposure to the weather for years.

The outside of the hive should be thoroughly painted, to keep it rain and damp proof. It must be placed on its stand in a spot sheltered, if possible, from the cold north and east winds, and with a free flight for the bees in front. Space should be left behind it for easy access, so that all manipulations can be carried on from the back ; this avoids irritating the bees going to and from the entrance.

The Swarm and its Treatment.

The swarm should be ordered either from a recognised dealer or from a neighbouring bee-keeper. The safest way for a beginner to start is with a "head" or first swarm. By this means he will avoid all the pitfalls of disease or lack of condition, which only a practised eye can detect, but which beset the purchaser of second-hand stocks. Given a good season, a swarm should be able to establish itself, and provide some surplus for its owner, in its first year.

When the box or skep containing the swarm arrives, it must be placed in the shade near the hive the bees are to occupy. The screws of the lid of the box should be taken out; or in the case of a skep the cording and wraps should be removed, and in the latter case the skep should be placed on a board, with a fair-sized stone under its edge, to allow of ventilation. The bees will soon quiet down, and cluster, after the shaking up of their journey, and thus will be in a condition for handling easily.

In the early evening the hive must be prepared to receive the swarm. The shallow-frame lift or section-super should be taken away, leaving only a thin quilt over the frames, which have already been fitted with brood-foundation. Then the front of the hive must be raised from the floor-board about an inch, by means of two wedges. Next, a board, the width of the hive, is placed in front of, and level with, the alighting-board, sloping down to the ground. This temporary board and the alighting-board are covered with a cloth hanging over the sides to the ground, to prevent bees from crawling underneath. Then the skep or box is taken between the palms of the hands, and carried mouth downwards, until it is just above the sloping board. With a smart jerk, the bees are thrown out in front of the hive, and they will at once begin to take possession of their new home. As they run in, watch should be kept for the queen. It is a satisfaction to see her safely enter her abode. When all are in, the wedges should be taken away and the front of the hive lowered to its proper place. Crushing of any of the bees must be avoided. Any that are in danger may be cleared away with a feather.

If the swarm has been a long time on its journey, or if the weather is bad on its arrival, the bees will be greatly benefited by being supplied with half a pint of warm thin syrup, given through an opening in the quilt by means of the bottle-feeder.

On the second day after hiving, the quilts should be turned back from the ends of the frames to ascertain if the "foundation" remains properly fixed, and to see if the work is going forward well. If this is the case the quilt may be taken off and the queen-excluder put on in its place. Over this a lift of shallow frames should then be placed and covered warmly with a quilt and carpets. The stock may now be left alone till the end of the honey season. More skill is required for obtaining comb honey in sections in good condition, but the section rack may be used instead of the shallow frames, if desired.

Conditions conducive to Success.

It is important that the beginner should clearly understand the principles that underlie successful bee-keeping. A colony of bees consists of a queen, a large number of worker-bees, and (during summer) a certain proportion of drones. The strength of a healthy stock depends on the vigour and laying power of the queen, who is at her best in her second season, *i.e.*, a queen hatched in June, 1912, will be at her best in May, 1913, and should be replaced by a young one in 1914, either by natural swarming or by re-queening. Queens may be purchased, or raised by the methods described in text-books. The economy of a hive depends, *first*, on the keeping up of the warmth of the brood nest (by means of the heat evolved from the bodies of the clustering bees) to such a point as will stimulate the queen to lay eggs, and enable young bees to be reared; *secondly*, on the feeding of the queen, the nursing of the brood, and the cleansing of the cells for the queen's use; *thirdly*, on the collection of pollen, water, and nectar for the brood; and *lastly*, on the building of storage combs and collecting nectar for the future supplies of honey.

The first three of these conditions must be fulfilled before the last can be begun; therefore, it is only by means of a large and vigorous surplus population that a stock can gather enough stores for its future use, and provide also for the bee-keeper. *The aim of the bee-keeper is to keep his stocks strong*, for a weak stock is always unprofitable.

The next consideration is, that the crowded condition of the hive should be secured at the right time, *i.e.*, at the honey-flow. Honey is the concentrated nectar of flowers. Spring and early summer are the times when the land is gay with a wealth of blossom, and the honey-crop is gathered. Late summer and autumn are times of seed and fruit, and only a gleaning of nectar from bramble and wild flowers then remains. There is a period every year, varying in each district according to soil and altitude, when the supply of nectar is most abundant. This time should be ascertained by the bee-keeper, who will then stimulate his

stocks beforehand, so that they may have their largest population ready to gather the produce of the various flowers.

Diseases.

Diseases are best guarded against by having dry, weather-tight hives and vigorous queens, and by giving suitable food when feeding is requisite.

The following are the chief maladies to be apprehended:—*Bee-pest*, better known as *Foul-brood*, an infectious disease which attacks the larvæ or brood and so destroys the colony. This is described in Leaflet No. 32. *Microsporidiosis*, better known as *Isle of Wight Disease*, a highly infectious disease which attacks the adult workers, and occasionally the queens. This is described in Leaflet No. 253. Both these diseases are now common in many parts of Great Britain, and should be dealt with promptly whenever they occur. *Dysentery*: it is doubtful if this is a real disease. It is a common symptom in Isle of Wight Disease, but it may be caused by undue winter confinement, unsuitable food and damp hives. It may also be caused by fermenting pollen, and many cases of supposed Isle of Wight Disease are in reality due to this cause. In the former case it is infectious—in the latter it will not spread if the defect be remedied. *Chilled-brood* and *Paralysis* are caused by damp and cold, though it is probable that many of the deaths attributed to this are really due to an attack of Isle of Wight Disease.

A word of warning and encouragement on one other point must be given. One can seldom keep bees without being stung: the sting of a bee is painful but harmless (except in rare instances), and in time, after many stings, the effect is so slight as to be quite disregarded. It is advisable to wear a veil to protect the face and head, but the hands should be left bare. Their best protection is the gentle, careful manipulation of the bees while attending to them. Those who propose to keep a few stocks of bees only, may proceed in the manner outlined above: anyone intending to keep a large number of stocks is advised to get a season's instruction in a well-managed apiary before laying out capital in the business. In conclusion, it may be remarked that bee-keeping is an interesting and, to some extent, a profitable occupation, but it requires considerable patience and care, without which success cannot be attained. It is not always easy, moreover, to find a remunerative market for the honey.

The preparation of honey for market is dealt with in Leaflet No. 141.

The British Bee-Keepers' Association (Secretary, Mr. W. Herrod-Hempsall, F.E.S., 23, Bedford Street, Strand, London, W.C.) is the head-quarters of apiculture in Great Britain.

Whitehall Place, London, S.W.1,
July, 1905.
Revised, October, 1914.

Leaflet No. 129.

BOARD OF AGRICULTURE AND FISHERIES.

Winter Egg Production.

This Leaflet has been temporarily withdrawn: See statement in Prefatory Note.

Leaflet No. 130.

BOARD OF AGRICULTURE AND FISHERIES.

Navel Ill and Joint Ill in Newly-born Animals.

This disease is met with, under such local names as Big Joint, Joint Evil, Schooley, in most parts of the British Isles.

Cause.

The disease is caused by the entrance into the system of the newly-born animal, through its unclosed navel, of germs which may give rise to the formation of pus or matter. It is possible, however, that germs which are not pus forming, but which may cause serious illness in animals, may also enter the system by the navel wound. These germs are widely distributed in nature, but are found in greater numbers and probably in a more virulent form on those spots frequently soiled by animals, such as farmyards, lambing yards, &c., than in the fields. For this reason permanent foaling and calving boxes and lambing sheds or sites for temporary yards used continually are more dangerous places than the pastures.

Symptoms.

Affected animals are noticed a few days after birth to be moving stiffly and to be disinclined to walk or suck. They lie down continually, and with difficulty are got on to their legs. Their joints begin to swell, and often it is apparent that abscesses have formed—the hock, stifle, point of the shoulder and knee being the joints usually affected. In the worst cases abscesses form in different parts of the body (particularly the kidney and liver), and the lamb dies from exhaustion or from the poisons produced by the germs of the disease. Other germs which do not necessarily cause Joint Ill may give rise to blood-poisoning, and kill the lambs more quickly, with symptoms of brain trouble and diarrhœa.

Prevention.

Every outbreak on a farm may add to the number of these germs, and so increase the probability of future attacks. On the other hand, if outbreaks are prevented, the germs become fewer in number.

Efforts must then be made to prevent the occurrence of cases on a farm by preventing the germ gaining access to the navels of newly-born animals, and to the system through the imperfectly closed navel. In foals and calves this object is best attained by ligaturing the umbilical cord (navel string) immediately after birth with a piece of strong string which has been soaked in 5 per cent. solution of carbolic acid in water or in any equally effective disinfectant and by applying a disinfectant to the navel in the form of an ointment or in solution.

If an affected animal is housed in a building, the final disinfection of the building and the litter after its removal must be very thorough.

As this disease among lambs more often assumes epizootic characters than among foals and calves, the preventive measures to be adopted to safeguard lambs are given in greater detail.

1.—A site for lambing the ewes must be chosen as free from infective material as possible, and there is no doubt, other things being equal, that ewes lambing in the fields rear a greater number of lambs than those in temporary or permanent lambing yards. Shelter, if necessary, can be provided by strawed hurdles set up about the fields in the form of a cross, or arranged to break the prevailing winds. The lambing field should, if possible, be changed each year.

2.—The system in vogue in some counties of passing the whole flock of ewes, if a big one, through one lambing yard cannot be too severely condemned. A large flock should be split into as many divisions as convenience will allow; it is then possible to confine disease to the division in which it occurs. If the lambing yard system is adopted it is imperative that a fresh site should be chosen each year.

3.—All dead lambs and the membranes in which they are born should be buried promptly. Straw on hurdles and for bedding should be renewed occasionally, and hurdles should be lime-washed. Manure and straw from hurdles should be placed in a heap and burned, and should never go on to sheep pastures. At the end of the season the site of the yard should be sprinkled with lime and the hurdles lime-washed.

4.—Care should be taken that the shepherd does not carry disease from ewe to lamb or from lamb to lamb. A shepherd's hands must be continually and scrupulously cleansed

with soap and water. They must also be disinfected, nails being kept short and scrubbed with a nail brush. His clothes should be covered with a lambing coat which should be frequently washed and disinfected. Dead ewes or lambs should not be skinned by the shepherd.

5.—A little disinfectant should be applied to the navel of each lamb immediately after birth. Stockholm tar has been found useful for this purpose.

6.—A ewe which has given birth to a dead lamb should not be allowed to run with the healthy ewes and lambs. If a ewe loses her lamb from this disease it is not safe to "mother" a fresh lamb on to her, as this lamb often becomes attacked. The expedient of putting the skin of a ewe's dead lamb on another to be adopted by her should on no account be resorted to.

7.—Ewes which have lost their lambs should be carefully watched, as it is possible that germs from the lamb may have found their way into her teats and produced inflammation of the udder, which, if it does not kill the ewe, will probably prevent the gland secreting milk in the future, and so render her unfit to breed again.

8.—The site of the lambing yard in which diseased lambs became infected should be immediately changed and the hurdles re-strawed and disinfected. If an infected field is believed to be responsible, the sheep should be moved on to fresh ground. In this way it is possible to avert a serious outbreak.

Treatment.

The disease in foals and calves should be treated by a veterinary surgeon, for the animal's life and future usefulness often depend on careful nursing and skilful administration of drugs, while surgical knowledge is indispensable when it is necessary to open deep-seated abscesses.

When the disease appears in lambs the advice of a veterinary surgeon should be sought as regards treatment of the affected, prevention of spread of the disease in the flock, and means to avoid unnecessarily soiling the farm.

If the smallness of the flock or distance from a veterinary surgeon renders veterinary advice out of the question, the following measures should be adopted.

The affected lambs, with their mothers, should be isolated on a spot not likely to be used for sheep for some time. If only a few lambs are attacked it will be found cheaper to kill them and dry off the ewes, as only a small percentage of survivors grow into sheep which show a profit. If a large number are attacked, it is then worth while employing a man to nurse them who does not go near the healthy flock.

The symptoms should be treated as they arise. Superficial abscesses should be opened with a sharp knife and then washed with a disinfectant. The evacuated matter should always be disinfected. The udders of the ewes should be carefully examined for the lambs sometimes infect them. Bottle feeding will be necessary for the worst cases, and care must be taken that a lamb does not lie always on one side, as the limbs of that side are likely to waste or become paralysed.

Whitehall Place, S.W.1,
February, 1905.

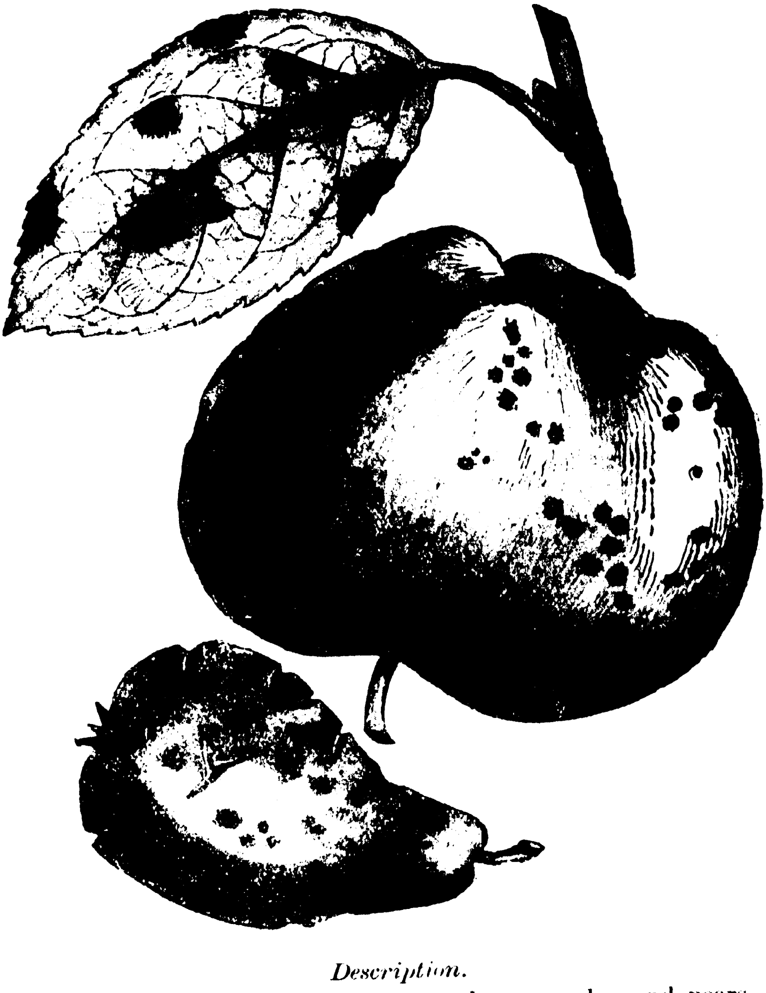
Revised, September 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 131.

BOARD OF AGRICULTURE AND FISHERIES.

Apple and Pear Scab (*Venturia inaequalis*, Aderhold, and *V. pirina*, Aderhold).



Description.

Although the fungi causing scab on apples and pears respectively are different species, they are very closely allied; but as the general appearance of the disease and the methods of treatment in each case are identical, separate descriptions are not necessary.

Scab is probably the most general and most widely distributed of fungus diseases attacking apples and pears, and during certain seasons the entire crop is much depreciated in value, or rendered altogether unsaleable, owing to the presence of numerous blackish blotches or scabs and gaping cracks on the surface.

To the casual observer scab is only recognised on the fruit, whereas in reality the fungus appears first on the leaves and young shoots, from whence the spores are washed by rain on to the fruit, which is the last to be attacked. If the fruit is nearly full-grown before it is infected, the spots formed by the fungus remain small and are irregularly scattered over the surface.

Although the market value is thereby depreciated, such fruit is not materially injured, the scabs being quite superficial.

If, however, infection occurs when the fruit is young, its further growth is checked; the surface becomes more or less covered with scabs of various sizes, and at a later stage is irregularly cracked.

On the leaves and young shoots the fungus forms minutely velvety, dark coloured patches, which have an olive-green tint when the spores are ripe. This clue is sufficient to enable this disease to be distinguished from Apple Leaf Spot (*Sphæropsis malorum*, Peck) dealt with in Leaflet 281.

Treatment.

(1.) In winter all diseased shoots should be cut away just below the point of the previous year's growth, and also any older branches showing indications of the disease.

(2.) When the leaf-buds begin to swell, but before they expand, the trees should be sprayed with full-strength Bordeaux mixture (*i.e.*, 12 lbs. of copper sulphate and 8 lbs. of quicklime to 100 gallons of water). The spraying should be repeated with half-strength Bordeaux mixture just before and after blossoming and again, a fortnight later, if disease is seen on the leaves. If spores are once allowed to mature the case is practically hopeless, owing to their enormous numbers and rapid dispersion. The spraying should be done at intervals as found necessary until the apples are about the size of a hazel-nut.

Strong Bordeaux mixture must not be used, otherwise the foliage may be scorched.

(3.) Under certain circumstances and in certain districts some varieties of apples are liable to be injured if sprayed with Bordeaux mixture. Growers should ascertain experimentally whether their trees are liable to this injury before operations on a large scale are undertaken, and should their trees be found to be susceptible lime sulphur solution should be used instead. This is prepared by putting 10 gallons of

water into an iron or zinc receptacle, under which a fire is burning, adding 48 lbs. of quicklime, and when the slaking is well started adding 90 lbs. of sulphur. A thin even paste must be secured by proper mixing, and then water added till 50 gallons is obtained. This must be boiled for an hour, after which it must be cooled and strained. The preparation should be further diluted before use. Lime sulphur wash is now made by many firms of repute, and small growers would do well to purchase the factory-made article in preference to attempting to prepare it at home. The manufacturer should be asked to guarantee that the concentrated wash is of 1·30 specific gravity. One gallon of such concentrated wash should make 30 gallons of full strength wash or 60 gallons of half strength.

The use of lime sulphur wash is still in the experimental stage, and all authorities agree that weather conditions, *e.g.*: heat, cold, wetness and drought, must be studied as well as the susceptibility of the different varieties of trees treated and the strength of the wash varied accordingly; but experiments conducted at the S.E. Agricultural College, Wye, in 1911 indicate that it can be used at full strength (1·01 specific gravity) on Worcester Pearmain, Bismarck, Beauty of Bath, Newton Wonder, Gladstone, Lady Sudeley, Ecklenville, Warner's King, and some others. Half strength (1·005 specific gravity) should be used on Wellington, Cox's Orange Pippin, Hector Macdonald, and on others.

(4.) When the disease has been present in an orchard all apple and pear trees should be thoroughly drenched with a solution of sulphate of copper—1 lb. of the sulphate to 25 gallons of water. This should be applied during the winter, before the buds begin to swell, otherwise the foliage will be completely destroyed. This winter wash is of great value in destroying fungus spores present in crevices in the bark, and should be regularly applied as a preventive.

(5.) The fungus may tide over the winter in fallen diseased fruit and leaves; such fruit and leaves should as far as possible be gathered and burned.

Whitehall Place, London, S.W.1,
March, 1905.
Revised, April, 1914.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W. 1. Letters of application so addressed need not be stamped.

Leaflet No. 132.

BOARD OF AGRICULTURE AND FISHERIES.

Slugs and Snails.

Slugs (Family *Limacidae*) and Snails (Family *Helicidae*) belong to the class of Invertebrate (without a backbone) animals known as MOLLUSCA ; they live entirely on land. The majority of snails prefer a green diet, *i.e.*, living plants of all kinds. Many slugs also live upon green plants but others prefer dry vegetable and animal substances and take green matter only when compelled to.

Slugs are very destructive to crops. Fields of cabbage and wheat have been destroyed ; in a case reported from Yorkshire in 1909 half the crop of barley and oats was destroyed and the grass fields were seriously damaged by the grey slug. Sometimes in gardens it has been impossible to grow a crop of early peas or beans ; young potato sprouts are eaten ; flowering plants of many kinds have been attacked ; and the blooms and young fruitlets of gooseberry suffer severely.

Snails have a spiral shell into which the whole animal can be withdrawn. There is no horny lid on the snail's "foot" to close up the opening of the shell like that on the foot of a whelk, but after a snail has withdrawn itself into the shell for the winter the opening can be closed by a plate composed of a mixture of lime and the slimy substance known as mucus exuded by a part of the mantle called the collar.

Except in the genus *Testacella*, where the beginnings of a shell are found at the hind end of the body, slugs have no external shell. Most species, however, have an undeveloped plate-like shell or at least a few limy granules hidden below the skin of the back. The region over this shell is known as the "shield."

Snails and slugs have a fairly well developed head region, and a muscular "foot" on which they crawl. They also possess a rasping tongue-like ribbon known as the "radula" ; this "radula" bears rows of horny teeth, and under the microscope resembles a file ; it is worked by muscles, and is used to scrape off particles of food. On separating the lips of the snail can be seen a horny crescent-shaped jaw on the roof

of the mouth; this acts with the rasper, and enables the animals to cut leaves and leaf-stalks.

Both slugs and snails have male and female sexual organs in the same individual. Eggs are laid on or in the soil, or under heaps of leaves, or under stones. The young snail or slug resembles the adult externally.

Slugs and snails usually work at night or dusk, but in damp weather or after heavy rain they may be found in numbers in the daytime.

Slugs.

The commonest slug is the *Grey Field Slug*, which may be found in almost every garden and field in Great Britain.

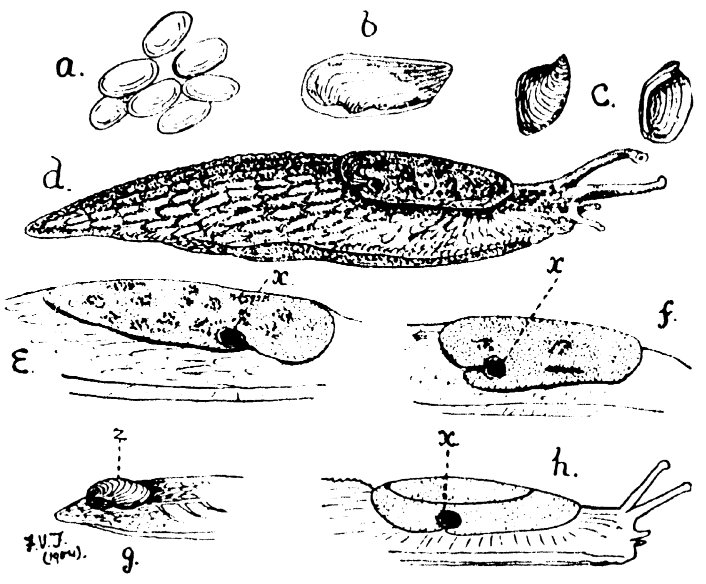


FIG. I.—CHARACTERS OF SLUGS.—*a.* Eggs; *b.* Shell of Slug (*Limax*); *c.* Shells of *Testacella*; *d.* Grey Field Slug (*Limax agrestis*); *e.* Shield showing respiratory pore (*x*) of an *Arion*; *f.* of a *Limax*; *g.* Tail end of a *Testacella* showing shell (*z*); *h.* Shield showing respiratory pore (*x*) of *Milax.*

It is one of the most prolific species of its race. A single individual is capable of laying as many as 500 eggs during the year. This slug resembles in general structure all other species. The upper portion of the body is long and rounded above, whilst the lower portion is flat and forms the so-called "foot." On the back will be seen an oval area which marks the site of the hard, thin shell-plate hidden under the

skin. The hole seen at the edge of this area, is the breathing pore. The grey slug lays its eggs in the earth and under rubbish, &c., from May to November. The eggs are round, milky, opaque bodies, and are deposited in batches of from six to fifteen. In from three to four weeks they develop into young slugs. When first hatched they are only one-twelfth of an inch long, and are very pale and soft. In common with other slugs, the grey field slug loves moisture. It works chiefly at night, and hides away during the day under stones, &c., and in the soil or under clods of earth when young. A shower of rain, however, soon brings it out during the day.

Slugs may be found at all times of the year, but in winter they usually take shelter under stones or logs, in the earth, and in rubbish heaps, where they remain in a semi-torpid state until the spring. Sometimes, when the weather is open, they are seen even in mid-winter. A small species, known as the *Bulb* or *Root-eating Slug*, passes the day under the ground, and comes up at night to feed on the leaves of plants. Like the earth-worm, this slug pulls down leaves into the ground and feeds upon them during the day, as it also does upon any roots or bulbs near it. A large *Black Slug* is also often noticed in gardens. This belongs to a different group from the Grey Field Slug; the breathing-hole will be noticed to be in front of the area over the shell, and not behind it. The Black Slug may reach four or more inches in length. It is commonly found in gardens, damp woods, and along dykes, and seldom attacks field crops. Like all slugs, it is very variable in colour, and produces a large quantity of slime.

Some slugs do not reach maturity for a year or more. They may then lay eggs and die. Others, such as the Black-striped Slug, may live for four or five years. The *Yellow* or *Household Slug* is also a large species which is found in cellars, sculleries and dairies, and about doors. It feeds upon many substances, including meal and flour, and is very partial to cream. It also feeds on beer drippings in cellars. It is of a dull, yellowish colour, and is often speckled with white and black, and has a bluish head and tentacles.

Slugs of the genus *Testacella* feed on worms and small animals. They may be recognised by the small shell being external. The prey is caught in the teeth of the rasping ribbon and drawn into the mouth.

Snails.

Snails usually feed above ground and so can be more easily destroyed than slugs.

The *Large Garden Snail* is one of the most widely distributed species and is very common in gardens. It is the largest garden species and is easily distinguished by its brown shell marked with pale zigzag lines. Eggs are laid in small batches in the earth, about 60 to 70 in each heap. Snails' eggs are white, shining, globular bodies and hatch in about 15 days. The young snails have very thin, transparent shells and grow rapidly. At the approach of cold weather they come together in heaps amongst rubbish in rockeries and ferneries, amongst the exposed roots of trees, and at the foot of hedgerows. They often occur in

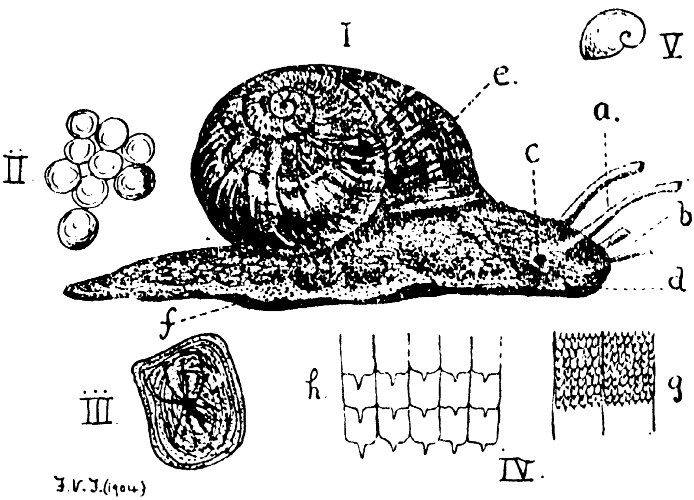


FIG. II.—THE GARDEN SNAIL (*Helix aspersa*).

I. Mature snail; *a.* large, and *b.* small tentacles; *c.* genital aperture; *d.* mouth; *e.* shell; *f.* foot. II. Eggs. III. Epiphragm. IV. Part of radula; *g.* a piece enlarged; *h.* teeth further enlarged. V. Young snail.

large masses united by the so-called epiphragms, *see* Fig. II., which they form to close the mouth of the shell.

Clover, sainfoin and upland pastures are often attacked by the *Wood Snail.* This is one of the first to make its appearance in the spring. The shell is very variable in colour, being white, grey, pale yellow, pink, and brown, with one to five spiral brown bands and a black edge round the mouth.

The *Strawberry Snail* is a small snail, seldom more than half-an-inch long. It is essentially a garden pest and is particularly troublesome in strawberry beds and amongst violets. Iris and other garden plants are frequently ruined

by it. The shell is much flatter than in the common large snails and is dirty-grey, reddish-brown or brown in colour, with numerous brown transverse streaks and a white spiral band around the last whorl. It feeds at night and is seen during the day only after rain. The eggs are laid between August and November, and hatch in from 20 to 25 days. Each snail may lay as many as 60 eggs, either in or on the ground. They hibernate like the large garden snail.

In fields and gardens near the sea the *Small Banded Snail* is one of the worst culprits. It is also found further inland and especially along "down-sides." The shell is conical and creamy white, with a single purplish-brown band above and others below. Snails of this species come out in great numbers during damp weather, and swarm over herbs and bushes, and attack wheat, mustard and field crops generally. They never seem actually to hibernate.

Several other kinds occur in garden and field and do damage to plants.

Natural Enemies of Slugs and Snails.

By far the greatest natural enemies to slugs and snails are birds, especially the thrush, which not only eats many slugs, but is also very partial to snails, breaking their shells against a stone and picking out the mollusc. Blackbirds devour large numbers of slugs, as also do starlings. Poultry and ducks eagerly search for both slugs and snails. Rats, voles, hedgehogs, moles and shrew-mice all help to keep down the number of slugs. Frogs and toads devour slugs and small snails. Centipedes attack slugs, and among the insect enemies of slugs and snails are beetles, ants, and some flies.

Prevention and Remedies.

The following measures will help to prevent or lessen the attack of these pests :—

(i.) Damp land should be drained.

(ii.) Where slugs are abundant the use of long manure, or organic manures generally should be avoided. Artificials should be used *for a time* instead.

(iii.) Dry dressings of some irritant to kill the pests may be tried. (*a*) Soot and lime ; (*b*) salt and lime ; (*c*) lime and caustic soda ; or to act mechanically, (*d*) powdered coke.

The lime should be in a very finely-divided state and quite fresh. *Two or three dressings should be given*, the second some 15 to 30 minutes after the first. A mixture of lime and caustic soda is found to act best—four parts of caustic soda to

96|of lime well mixed. Dry dressings, except powdered coke, should be applied very early in the morning.

(iv.) "Rings" of slaked lime or fine ash soaked in paraffin may be put round choice plants. Heavy applications of soot keep off snails.

(v.) Rows of peas, etc., can be protected either by spreading barley sweepings or cinders and lime along the rows, or by applying heavy dressings of slaked lime.

(vi.) In gardens and hop plantations heaps of bran-mash or moist oatmeal or cabbage and lettuce leaves may be placed here and there. These baits attract the slugs, which should then be collected and destroyed.

(vii.) Boards, smeared with fat on the under side, may also be used with satisfactory results; these should be laid along garden beds or in infested places, room being left below for the snails to collect.

(viii.) In plant houses tender blossoms may be protected by twining some cotton-wool round the stem or flower stalk.

(ix.) Rockeries, ferneries, hedge bottoms, and rough herbage at the base of walls should be cleaned out in winter and the masses of hibernating snails crushed.

(x.) Land that is thoroughly fouled with slugs should be treated with gas-lime and be deeply trenched in winter.

(xi.) If the pests come from a neighbouring copse or spinney, a deep trench should be dug and filled with lime or tar, in order to trap them.

(xii.) Ducks and poultry should be kept in hop gardens in late autumn, and in spring, and also whenever possible should be penned on garden land.

(xiii.) Thrushes should be encouraged. It is easier to keep them off the fruit than to suppress the snails and slugs which they largely devour.

Whitehall Place, London, S.W.1.
March, 1905.
Amended, March, 1917.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 133.

BOARD OF AGRICULTURE AND FISHERIES.

Powdery Mildew of the Vine

(*Uncinula spiralis*, Berk. and Curt.).

Description and Life History.

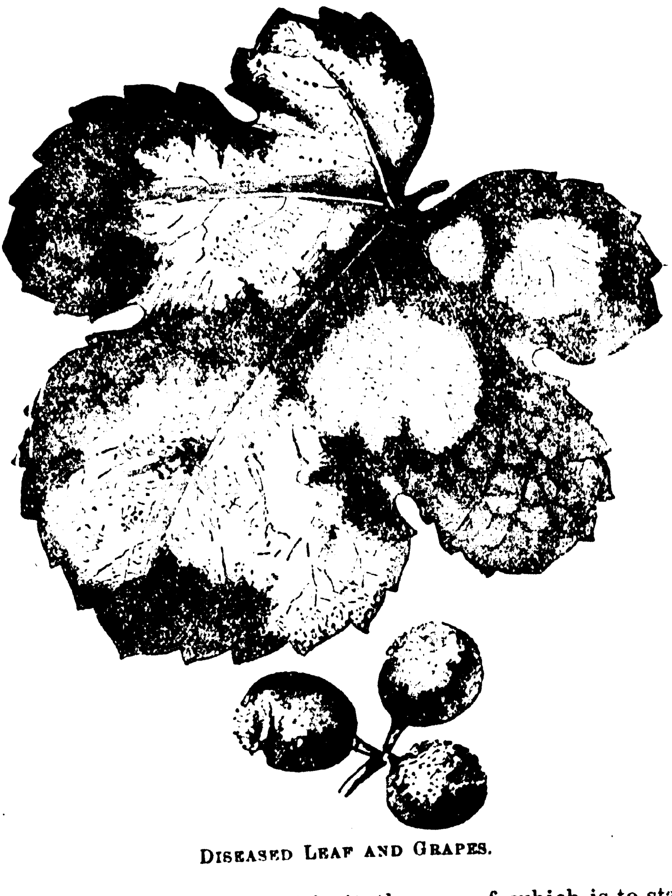
This destructive disease is caused by a minute parasitic fungus, which in the first instance is supposed to have invaded European vineyards from the United States, where it is commonly met with on both wild and cultivated vines. In its native country two kinds of fruit are produced by the fungus—the summer form, appearing as a white mildew on the foliage, and an autumnal form, in which the spores are enclosed in special receptacles, and remain in an unchanged condition until the following season. In this country the summer or mildew form of fruit only has been observed, and this was described by the Rev. M. J. Berkeley so long ago as 1845 under the name of *Oidium Tuckeri*. During the spring the fungus forms very delicate white patches on the upper surface of the leaves, and on young shoots and fruit; as the season advances these patches spread until, frequently, the entire surface of the leaf is covered.

The spores are formed in immense numbers, and remain on the leaf in the form of a white powder until scattered by wind, insects, spraying, &c. If preventive measures are commenced sufficiently early the disease is not difficult to check, but if spores are allowed to mature and become dispersed, success is by no means certain.

Treatment.

(*a.*) On the first appearance of small, scattered white patches of mildew on the upper surface of the foliage, every part of the plant should be sprayed with a solution made by dissolving one ounce of potassium sulphide in three gallons of water. Spraying should be repeated as occasion demands. Even in the absence of any evidence of disease, but more especially if the disease has previously existed in the neighbourhood, all vines should be sprayed. The first application should be made about a fortnight before the flowers expand, the second when in full bloom—care being taken at this time not to use too much force in spraying, in order not to injure the flowers. A third spraying may follow after an interval of three or four weeks if the mildew was present and has not been completely destroyed.

The use of a soluble sulphide for spraying, as recommended above, is preferable to the older methods of dredging with flowers of sulphur, or of placing sulphur on hot pipes. If spraying is properly done, the advantages are: (1) the greater certainty of covering every part of the plant with the solution; (2) greater cleanliness; and, (3) the avoidance of danger from too concentrated sulphur fumes.



DISEASED LEAF AND GRAPES.

(*b*.) The winter form of fruit, the use of which is to start the disease afresh the following season, has not been found in this country, and only on very rare occasions in any part of Europe; nevertheless the fungus possesses the power of living over the winter by means of mycelium which hibernates in the bark and buds of the vine. On the return

of spring this mycelium produces the first crop of spores, which on being scattered over the young leaves, soon attain the proportions of an epidemic if not promptly checked.

To ensure the destruction of this hibernating mycelium during the winter, when the vine is resting, the trunk and branches should be thoroughly drenched with a wash consisting of one pound of sulphate of copper dissolved in twenty-five gallons of water. The soil, walls, glass, etc. should also be drenched with this solution, which, it is very important to remember, should only be applied during the winter, before the leaf-buds begin to swell, otherwise the foliage will be completely destroyed.

(*c*.) All diseased leaves and fruit should be collected and burned.

Whitehall Place, London, S.W.1,
March, 1905.

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BOARD OF AGRICULTURE AND FISHERIES.

Apple Culture.

The information given in this leaflet is not intended to be exhaustive, and in many respects may need some modification according to the general nature of the climate and soil of any given district. It is hoped, however, that sufficient information is given concerning the broad principles of apple culture to prove of substantial assistance to cultivators.

Situation of the Land.

If possible, the land selected should be well above the level of streams, but not so high as to be fully exposed to the prevailing winds. Land that slopes gently to the south-west and is sufficiently sheltered is best, if other conditions are favourable, as land inclining in this direction does not receive the full rays of the sun in the early morning before the temperature has risen, and the blossoms of the trees are, therefore, not so liable to suffer in frosty weather.

The Soil and its Preparation.

Land that will grow good wheat will grow good apples. Very light sandy soil should be avoided, as should also heavy clays. It is most important that the land should be free from weeds previous to planting the trees, as it is impossible to clean it after they are planted.

Draining.—If necessary the land should be drained, but this point may be decided by digging trial holes 3 ft. deep in various places. After a good rain the holes should be inspected. If water has collected in them the land must be drained, but if they are practically dry draining will not be necessary. If draining is to be done, 2-in. drains should be laid, making them about 2 ft. to 3 ft. 6 in. deep, varying the depth of the drain according to the nature of the soil. The drains on heavy land should not be so deep as those on a lighter soil. Very deep drains are not so effectual in carrying the surface water from heavy land. The lateral drains should be formed across the slope, if possible, terminating in a main drain of 3-in. pipes for an area of not more than four acres. If a larger area is to be drained, the main towards the lower part should be of pipes proportionately larger. The distance between the lateral drains should vary according to the texture of the land, but two lineal rods is a very convenient

distance, and is generally effectual in medium land; 15 to 18 feet will be more suitable for heavy land. The drains should, if possible, be so arranged that they are between the rows of trees, and they should all be perfectly straight. The main drain should be slightly deeper than the laterals, the latter being connected with the top of the main. Lateral drains should not be at right angles to the main, but inclined in "herring-bone" fashion. If lateral drains must run at right angles to the main, a few feet near the junction should be inclined, otherwise the main drains may choke.

Manuring and Cultivating.—The land being drained, the next step is to manure and cultivate it. It is a mistake to make the land very rich for young trees. They are not capable of taking up large quantities of plant food; indeed, if the land is too heavily manured, they develop soft and coarse wood which ripens imperfectly. Soil that will produce good crops of cereals will grow apples well if a moderate dressing of manure, say 20 tons per acre, is applied for the young trees, followed by additional supplies when they are carrying heavy crops of fruit. The land should be cultivated to a depth of at least 18 in., either by trenching, by sub-soiling, or by steam scarifying. The last named is the cheapest method for large areas.

Protecting the Trees.

Hedges of damsons may be planted around the area to protect the trees from the wind, but if the land is of a heavy nature, black Italian poplars may be substituted for the damsons. The poplars should be cut in close and topped every year, thus forming a very stiff wind screen. In very exposed places a double row of Scotch or Austrian pines will be found effectual, but these will require more room than the poplars. If standards only are to be planted, wire netting may be placed around each of the trees as a protection against rabbits, or against sheep if planted in grass, but if a mixed plantation is to be formed it will be preferable to enclose the whole area.

Selecting the Trees.

The trees should be selected during the latter end of summer. The ordinary standard is the most suitable if the land is eventually to be used for grazing purposes; but low or bush trees may be planted more thickly, while they also give quicker returns. If possible, the intending purchaser should visit the nursery and inspect the trees previous to purchasing, thus avoiding, to some extent, the risk of getting unsatisfactory trees. No hard and fast line can be laid down as to the exact varieties to plant in various localities, but great care must be exercised to obtain the trees on suitable stocks. The crab is, in general, the most suitable for standard trees, and the Doucin or broad-leaved Paradise for bush trees; but the very free-bearing kinds, such as Lane's Prince Albert, do well as bush trees on the crab.

Types of Trees.

Two forms of trees, viz., the standard and the bush, are generally used for orchard planting, either separately or together. The bush trees give quicker returns and produce finer fruit than the standards, while the latter last longer, and, in favourable seasons, produce large crops of medium-sized fruit. To form an orchard that will serve the double purpose, viz., give quick returns and last for a long period, it will be advisable to plant standards with bush trees between. Standards may be planted 30 ft. or 36 ft. apart, with bush trees between, 10 ft. or 12 ft. apart. The distance between the trees must be regulated by the space required according to their habit of growth and the general character of the soil. The bush trees will commence to bear the second season after planting, and may be expected to produce good crops until the standards grow them out; the latter will not fruit so quickly, but will in time produce large crops of useful fruit. The average quality of the past will not withstand the keen competition of the present, and, as the bush trees can be planted more closely, give quicker returns and produce fruit of finer quality and appearance than the average standard, the planter will do well to consider his line of action before purchasing. The matter may be summed up as follows:—

Standards give but small returns the first few years, but last a long time if properly managed, and, in favourable seasons, yield good crops of fruit; but the crops are often severely reduced by wind.

Bush trees give quick returns, the fruit is generally clean, good in quality and appearance, and larger than that of a similar kind grown on standards.

Standards and bush trees mixed give crops extending over a long period, the heaviest early crops coming from the bush trees, and a long continuous supply from the standards when once they are brought into a fruit-bearing state.

*Kinds to Plant.**

COOKING.

STANDARDS.	BUSHES.
Beauty of Kent.	Bramley's Seedling
Bramley's Seedling.	Ecklinville.
Ecklinville.	Golden Noble.
Gascoyne's Seedling.	Lane's Prince Albert
Grenadier.	Potts' Seedling.
Lord Derby.	Sandringham.
Lord Grosvenor.	Stirling Castle.
Newton Wonder.	Warner's King.
Wellington.	Newton Wonder.
	Bismarck.

Ecklinville and Wellington should not be planted as standards on heavy land.

* A statement showing the best varieties for planting for market purposes in different districts of Great Britain was published in the Board's *Journal* in April, 1908. (The *Journal* may be obtained direct from the Offices of the Board, price 4*d*. per month, post free.)

DESSERT.

Standards.	Bushes.
Adams' Pearmain.	Adams' Pearmain.
Blenheim Orange (slow to come into bearing).	Allington Pippin.
Christmas Pearmain.	Beauty of Bath.
Devonshire Quarrenden.	Christmas Pearmain.
Fearn's Pippin.	Cox's Orange Pippin.
King of Pippins.	Lady Sudeley.
Allington Pippin.	King of Pippins.
Worcester Pearmain.	Worcester Pearmain.
	James Grieve.

Planting.

October, or early in November, is considered the best time for planting, but the trees should not be removed from the nursery quarters until the ground has been well soaked with rain, or the roots may be materially damaged. To define the position of the trees various methods have from time to time been advocated, many of them taking up a considerable amount of valuable time. All methods aim at one common end—viz., to get the trees into their proper position, and it is a rule that all newly-planted standard trees need staking. If a straight line is taken along one side of the proposed orchard, and another opposite, quite parallel, and one at each end at right angles, the four sides are defined. A stout, whitened stake should be placed at each corner. Stakes for sighting should then be placed at the distances apart that the trees are to be planted all along the four sides in straight lines. Three men should be employed, one directing from one of the base lines, another from one of the lines at right angles, the third to place the stakes to define the positions of the trees. If stakes suitable for the trees are used for this work, they may be driven into the ground firmly, and the holes dug around them for the trees. This method will avoid any further measurement or sighting. If standards are to be mixed with bush trees, care must be taken to place long stakes at the proper places.

The holes should be dug shallow and broad. Any damaged roots of the trees should be carefully pruned *from the under side* before planting, and the trees should be so planted that the roots are just below the surface of the soil. On land inclined to be wet, the roots may be slightly above the ordinary ground level in shallow mounds of earth. The trees should be secured to the stakes, care being taken to use straw bands to keep the trees secure yet quite clear from them, so that they do not get their bark chafed. Mulching with short manure should then follow, this mulching covering a space equal to the size of the hole before planting.

Pruning.

In order to ensure good results, pruning must receive careful consideration and be judiciously carried out. The question is fully dealt with in Leaflet No. 252 (*Pruning of Fruit Trees*).

Manuring.

Sufficient plant food or manure should be applied to the trees to keep them in a healthy but not too vigorous state of growth. If they have a tendency to grow strongly, manure must be withheld, but if they carry heavy crops of fruit it is quite evident that the supply of plant food taken from the land by the trees must be replenished or failure will ultimately ensue. If necessary a dressing of farm-yard manure at the rate of 20 tons per acre may be applied each winter, previous to cultivation, between the trees. The manure should extend as far from the stems as the boughs are long. Superphosphate and kainit are valuable plant foods for the apple, and may with safety be applied at the rate of from 3 to 5 cwt. each per acre, in addition to the farm-yard manure, if necessary. The amount applied should be regulated by the growth of the trees and the crops they produce. It is important that the soil should not be allowed to become deficient in lime, on account of the greater susceptibility of the trees to canker and other fungus diseases where lime is deficient. A good dressing of lime from time to time is very beneficial.

Washing.

The trees must be washed in the spring, when the caterpillars of the winter moth* appear—usually about the time the buds begin to burst, from the middle of March to the middle of April. Older trees, infested with lichen, &c., affording protection for many pests in embryo during winter, should be washed about the middle of February as described in Leaflet No. 70 (*The Treatment of Neglected Orchards*).

Sufficient whitening may be added to the winter wash at the time of spraying to define where the wash has actually been applied. This will ensure the whole of the trees being dressed.

Renovation of Old Trees.

The renovation of old-established standard trees is well worth close attention if they are good kinds. If the sorts are not of the best the trees may be headed down and good saleable kinds grafted on to them. Bramley's Seedling

* The methods of prevention and the washes recommended for use against the caterpillars of the winter moth are given in the Board's Leaflet No. 4. Among the other pests of apple trees dealt with in separate leaflets are Apple Blossom Weevil (No. 15); Apple Sucker (No. 16); Codling Moth (No. 30); Woolly Aphis (No. 34); Fruit Tree Beetle (No. 49); Canker Fungus (No. 56); Tent Caterpillars (No. 69); Brown Rot of Fruit (No. 86); Fungus Disease (No. 87); The Pith Moth (No. 90); Mussel Scale (No. 107); Apple and Pear Scab (No. 131); Apple Tree Mildew (No. 204); Apple Sawfly (No. 205); Oyster-Shell Bark Scale (No. 210); and Apple Leaf Spot (No. 281).

and Loddington will prove useful cooking kinds for grafting on trees of discarded varieties, while for dessert Allington Pippin and Worcester Pearmain may be used. If the trees are of good kinds, but impoverished, a dressing of 20 tons of farm-yard manure per acre, together with 3 to 5 cwt. each of superphosphate and kainit, should be applied early in the autumn, and should be well dug in if the land is arable. If the land has been laid down to grass the same manures may be applied as a top dressing, but their action will not be so apparent as on cultivated land.

All useless boughs, particularly those growing crossways in the trees, should be removed. When the thinning process is completed there should be room for a man to move freely between the main boughs. The trees should be thoroughly sprayed in February with the caustic winter dressing recommended in Leaflet No. 70, which deals generally with the treatment of neglected orchards.

*Packing and Grading the Fruit.**

Apples of the early kinds should be picked before they are quite ripe. They are not then so liable to bruise in transit as when quite ripe, and, moreover, they will ripen quickly when enclosed in the packages on the way from the grower to their destination; whereas, if allowed to become quite ripe, they would be softer, and would bruise far more freely in transit. The later kinds, that are to be stored, should be allowed to mature, or they will shrivel after they are picked.

The fruit is generally packed in bushel and half-bushel baskets, while some of the most successful growers use small barrels. These are better than baskets, as, the insides being smooth, the fruit does not bruise so freely. For the choicer dessert kinds light boxes may be used, in which case the lids should be fixed and placed downwards. The fruit should then be placed evenly upon what is then the lower part of the box, finishing at the top—which, when the remaining wood is nailed on and the box reversed, proves to be the bottom. The lid, which was originally the bottom of the box, is then at the top, and when removed exposes the carefully placed fruit to the eye of the purchaser. The boxes should be properly branded at the ends.

All fruit when packed should be carefully graded and sorted, so that only apples of an even, uniform size are packed together. At least two sizes should be made from each bulk. Mixed fruit of various sizes is practically unsaleable, more particularly as the foreign supplies are so very carefully sorted as to size.

*** Information as to the grading and packing of fruit and vegetables is given in Leaflet No. 98.**

Storing.

For preserving late kinds until selling time a suitable store-house must be erected. Fruit will keep no better in elaborate expensive buildings than in an inexpensive building of thatch and earth. A very suitable building may be made as follows :—

Place a row of posts, about 4 in. square, in a line, 2 ft. apart, say for a distance of 100 ft.; then place a second row parallel, and 12 ft. from the first, inside measurement. The posts should be 5 ft. high from the ground line. Place boards along the outsides of the posts on either side and also at the ends, where suitable doors should be arranged. Dig a ditch on each side of the posts, 3 to 4 ft. from them, and place the earth against the boards. This will prevent the frost from getting in at the sides. Suitable plates and rafters may then be put on to the two rows of posts, thus making a span-roof building. The top may then be thatched with reeds, straw, or heather. The ends should be double-boarded, and the cavities filled with sawdust. A ventilator should be placed in the apex at the ends. The floor line inside the house should be slightly above the outside ground level, and, if possible, the building should be erected on a gentle slope. The inside may be fitted with three rows of shelves or benches on either side.

An inexpensive store-house may thus be erected, and the later kinds of fruit stored until selling time. Free ventilation should be afforded for a period of six weeks after picking the fruits to allow the moisture to exude from them. Afterwards the store-house may be kept closed, maintaining an average temperature of from 38 to 42 deg. Fahr., as nearly as possible, but sudden changes in the outside temperature will naturally have some influence upon that inside the fruit store.

Whitehall Place, London, S.W.1,
April, 1905.
Revised, December, 1911.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 135.

BOARD OF AGRICULTURE AND FISHERIES.

Mange in Cattle.

Definition.

Mange is a contagious disease of the skin caused by parasitic mites or acari belonging to the family *Acaridæ*, a family which includes the mite causing Sheep Scab (*See* Leaflet No. 61) and Parasitic Mange in horses, asses and mules (*See* Leaflet No. 274).

Three forms of mange occur in cattle, viz.: *sarcoptic*, *psoroptic*, and *symbiotic*. These forms are named after the species of parasite which is the cause of the ailment. Sarcoptic mange in cattle is uncommon. The most prevalent forms are the psoroptic and symbiotic, and these two forms may exist together in the same animal. Cows are most often affected.

Sarcoptic mange is the most serious form. Its gravity arises from the fact that the sarcoptes burrow under the outer skin, forming minute tunnels in which the female lays her eggs. The eggs are hatched and the parasites multiply in the subcutaneous tunnels. The presence of the parasites gives rise to great irritation and discomfort to the animal, and a severe inflammation of the invaded skin is set up. Owing to the burrowing habit of the sarcopt this form of mange is often exceedingly difficult to cure as local applications to the skin cannot reach all the mites.

It is believed that cattle are liable to contract the sarcoptic mange of the horse and of other domesticated animals. In this respect sarcoptic mange differs from the other two forms of mange, which are not regarded as capable of spreading from one species of animal to another.

Mange is spread to healthy cattle by direct contact with affected animals or indirectly by contact with contaminated pastures, cowsheds, and utensils employed about mangy cattle.

The three forms of parasites differ in their habits, and show certain variations in size, shape, and anatomical characters which are readily distinguished when examined under a low power of the microscope.

The causal parasites of the two common forms may under favourable circumstances be seen by the naked eye, and their movements may be followed with the aid of a suitable hand lens. When they are only comparatively few in number, they are not so readily detected amongst the scab and debris.

The Sarcoptes are the smallest in size. They are more or less spherical in shape, the head is short and rounded, and they are capable of cutting through the outer skin under which they burrow.

The Psoroptes are the largest variety. They are oval in shape, the head is elongated, and the legs are long and thick, especially the anterior ones. The pedicle at the end of the legs which carries the sucker is long and articulated. These mites do not burrow under the skin but they bite, and feed upon the inflammatory secretions which ooze out on the surface of the skin in consequence of the irritation set up.

The Symbiotes occupy a middle position with regard to shape and size. They are also oval, the body is slightly notched along its posterior border, and the head is about as broad as it is long. These mites are the least harmful to the animal. They have a tendency to remain in one situation and feed upon the scurf and debris of the skin without biting.

All three forms are provided with hairs on the body and long hairs on the legs, and all have suckers at the extremity of two or more pairs of legs.

The females are larger than the males and more numerous; they lay a varying number of eggs, according to certain conditions, which appear to have a controlling effect on the multiplication of the parasites and the spread of the disease The eggs are laid over a period (not all at one laying), and some female parasites may lay as many as twenty, thirty or perhaps more. Within a week, at incubative temperatures, the eggs hatch and the minute young parasites (larvæ) with three pairs of legs emerge from the tiny shells.

The larvæ, after they are hatched, commence to feed. After a full meal they are engorged, and become torpid and motionless. In this condition they undergo what is termed a moult. The interior of the parasites begins to shrink into a ball-like mass, and separation takes place between it and the outer horny covering of the body.

The parasites remain in this dormant condition, for from one to two days.

At the end of the first moult a fissure or crack appears along the back of the old parasite, and a new form appears emerging from the opening in the cast or thin outer covering of the previous form.

This new form is termed a nymph, and the parasite has acquired an additional pair of legs during the process. The nymph in turn feeds and undergoes a moult (second moult). The second nymph stage is followed by another moult (third moult) when the fully developed adult male or female emerges from the separated cast. The males pair with the pubescent nymphs. The newly liberated ovigerous female begins to feed, and in the course of one or more

days commences to lay eggs. In this way the various stages are repeated, and the parasites rapidly multiply. The length of time necessary for a complete cycle to take place, under favourable conditions, is about twelve days. The eggs retain their vitality off the animal for about a week, the time depending on temperature and moisture.

All forms are capable of living away from the animal's body for some weeks, and fresh cases of mange in healthy cattle may occur even after mangy animals have been removed. A knowledge of this fact should at once serve as a warning against the practice of putting healthy cattle into cowsheds, which have been recently occupied by mangy cattle, until such places have been cleansed and disinfected. An infected stall or shed, unless its construction and state of repair allows of its being thoroughly disinfected should not be used for healthy cattle for at least a fortnight, or better, for three or four weeks.

Symptoms.

Psoroptic mange is the most common form amongst cattle, but a general description can be applied to the symptons seen in all forms.

The most common sites of mange are the root of the tail, the neck, the buttocks and the withers. The parts under the jaw and around the base of the horns may also be affected, and if the ailment is neglected the psoroptic form may spread over the shoulders and chest to almost any portion of the body, but it is rare for the legs to be involved.

As a result of the bite by the mite, a small spot of inflamed skin can be seen in the form of a red spot or pimple. The bites increase in number and the pimples become soft and yellow in appearance from the collection of plasma which has escaped from the minute vessels in the injured parts.

These papules break down, run into each other, and form a superficial sore of varying extent.

The exuded plasma dries, sticks the hairs together into hard tufts and in this way the coat begins to look ruffled, and even unsightly in appearance. The biting of the parasites gives rise to an itchy condition of the skin, which causes the animal to scratch or rub itself against other animals, or any fixed object, with the result that the hairs over the affected parts gets rubbed off exposing a bare scabby patch of skin.

From the presence of the parasite, and owing to the continued rubbing by the animal to relieve the irritation, scurf and scales are thrown off, and can be seen on the surface of the skin. Closer examination shows red and yellow blood scabs. The inflammation of the skin is increased by rubbing and there may be wounds or bleeding sores, if the animal

has been rubbing against rough objects. Large raw scabby areas of skin denuded of hair may be seen.

Amongst the scab, and more especially round the margin of the crust, the mites are usually to be met with in greatest numbers. They may be seen with the naked eye or better still with a hand lens. The multiplication and feeding of the mites goes on around the main scabby parts, and in this way the scabby area is increased in size. Some of the parasites wander on the body and set up fresh centres of scab, or they may be rubbed on to other cattle or objects.

As the parasites leave the older centres of disease these parts become dry and hard. The skin loses its elasticity, becomes parchment-like. It is sometimes wrinkled, and has a corrugated appearance.

The denser scabby parts crack across in all directions and deep fissures or crevices appear, from which blood or plasma escapes. This condition is best seen on the neck and fore part of the body.

As the disease progresses and the irritation is increased the animals become very restless, they are continually rubbing, biting and scratching themselves. They go off their food, the milk yield is diminished, they rapidly lose condition and flesh, and have a very unthrifty and wasted appearance. The affected cattle may become weak, anæmic and debilitated.

It can only be the result of negligence when cases become advanced, as with ordinary care and attention the disease can be detected in its earliest stages, and with proper treatment cured. A good watch should be kept for a chronic case, in which the mites are few in number and the affected parts small in extent. Such a case in a herd of cattle, while it may be the means of spreading the disease amongst the other animals, may itself escape attention.

It is advisable that examination should be extended to the head, particularly under the jaw and around the base of the horns. The point and under surface of sternum or breast should also be inspected, as occasionally in individual animals a number of mites may be collected in these situations, showing little, if any, inclination to spread, and causing no special inconvenience to the animal so affected.

The symbiotic form, also spoken of as tail mange, is usually confined to the parts around the base of the tail. It has a distinct tendency to remain localised ; only rarely and in badly neglected cases does it spread over the body. With the prompt use of effective remedies it should quickly yield to treatment.

In cases of rapid wasting it should be borne in mind that the wasting may be due to some serious internal trouble such as tuberculosis or other wasting diseases, which reduce the animal's natural power of resistance to the less serious disease.

It has not infrequently been observed that cows appear to become cured spontaneously when turned out to grass in the spring. This usually means, however, that under open air conditions the parasites do not increase at the same rate, and hence the active symptoms are merely less marked.

When the animals are again brought into the sheds in the autumn the acari (parasites) which have persisted in small numbers resume their activity, and this sometimes leads to an erroneous belief that re-infection has taken place.

Treatment.

In some countries, where cattle are kept in large herds and a number of them are affected at one time, the affected and contact cattle are dipped like sheep in a prepared dip. If the numbers are large the cattle can be driven through a swimming bath, or should a dipping tank for cattle not be available the dip can be applied by means of a spraying pump.

Another method of treatment is to wash the affected patches on the animal's skin with soap and warm water, and then dress the parts with one of the common mange dressings, such as spirit of tar, linseed oil, and sulphur, or an efficient sheep dip might be used. The dressing should be applied twice or even three times at intervals of ten days. In serious and rebellious cases necessitating treatment of the whole body, veterinary advice should be sought.

The litter from an infected animal should be removed and burnt each time after dressing, and the flooring and wood, or other fittings used about affected animals should be well sprayed with a five per cent. solution of carbolic acid in water or other standard carbolic preparations which are miscible with water.

Whitehall Place, London, S.W.1,
April, 1905.
Re-written, September, 1913.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 136.

BOARD OF AGRICULTURE AND FISHERIES.

The Bulb Mite (*Rhizoglyphus echinopus*).

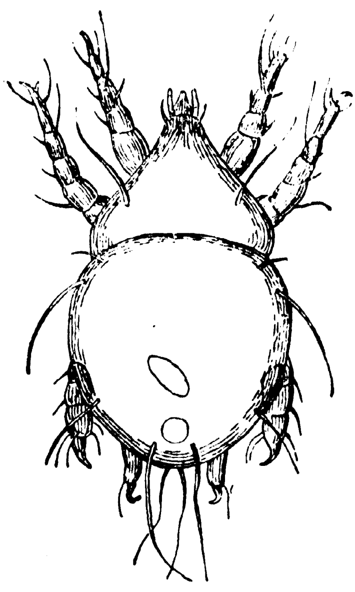

FIG. 1.
Adult Male, magnified 95 times.

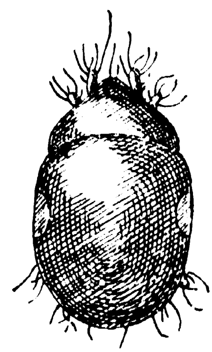

FIG. 2.

Hypopus, magnified 100 times.

(Both figures after A. D. Michael.)

The genus *Rhizoglyphus* belongs to the family *Tyroglyphidæ*, a family of mites with a comparatively small number of genera and species, but a great number of individuals, which may be found together in masses. Familiar examples of the family are the cheese mites, the hay mites, and a species which has several times been found swarming over furniture, curtains, &c., in houses. The family is interesting biologically, as amongst its members is found, in addition to the stages in the life-history of mites in general, the *hypopus* stage, this being a stage developed for the purpose of the spread of the species. Besides other differences, it is characteristic of the hypopus that it possesses suckers by which it can adhere to flying or passing animals, and thus be

conveyed to fresh feeding grounds. In this stage the mite is able to resist conditions which would be fatal to it in its other stages. All the individuals of the same generation do not pass through this hypopial stage.

There are two British species of *Rhizoglyphus*, viz., the Bulb Mite or Tulip Mite (*R. echinopus*) and *R. agilis.* The latter, discovered by Michael on decaying cabbage stalks in the South of England, is narrower in body, lighter in colour, and more active in habit than the Bulb Mite.

Food Plants of the Bulb Mite.

Rhizoglyphus (root eater) *echinopus* (spiny legs) feeds on underground swollen stems and roots, *e.g.*, the bulbs of the tulip, lily, hyacinth, onion, eucharis, and the tubers of the potato and dahlia, and can pass from one of these plants to another. It has also been taken in destructive numbers on the roots of the vine. This mite has been distributed all over the world in its food plants. Signs of infestation by the mite are :—

(1.) Checking of the plants, the leaves turning yellow.
(2.) Failure to produce flowers.
(3.) Reddish-brown spots on the scales of the bulb, indicating feeding places of the pest.

There has been some controversy as to whether the mites are really the cause of the failure of the bulbs. Some maintain that the decay of the bulb is due to error in treatment, *e.g.*, in Eucharis bulbs to over-forcing, bad drainage, faults in temperature or moisture, or shade, and that the decaying bulbs are then attacked by the mites. Michael, however, by many experiments, has placed it beyond question that the mites attack, and indeed prefer, sound bulbs, and they have been found at their destructive work in otherwise good tulip bulbs.

Description.

R. echinopus can be found in the stages of egg, larva, nymph, hypopus, adult males of two forms, and female. The adults have a smooth body, which is yellowish white in colour, and tinged with pink. The legs and rostrum are red. Each mandible ends in a pair of pincers, the branches of the pincers bearing three teeth. Just behind the second pair of legs on each side of the body is a projecting hair. There are four pairs of short thick legs, the two front pairs being the strongest; the legs are five-jointed, bearing spines and hairs, and each ending in a single claw. The male has the abdomen more rounded at the end than the female; the hind part of the cephalo-thorax in the male is as wide as the abdomen, but in the female it is not quite so wide. In one of

the two forms of male the third leg on each side is thicker, and is not used in locomotion. The hypopus carries on the middle of the under surface of the hind region a horny plate with twelve suckers; in front of this plate are two additional suckers.

The mites, which are extremely minute, need for their examination a good lens or microscope. There is very considerable variation in their size; Michael gives ·53 mm. for the male and ·55 mm. for the female as typical lengths for British specimens.

Life-History.

On hatching from the egg the larva bears six legs. After feeding for a short time this six-legged larva becomes inert and moults. The new form has eight legs, and is known as a nymph, and it is during this stage that the greatest growth takes place. In ordinary circumstances the nymph—according to Michael's experiments—probably moults twice, each moult being preceded by a sluggish period; the last moult of the nymph is succeeded by the sexually mature adult. Where, in the life-history of the individual, a hypopial stage appears, the number of moults is greater than the above. Larva, nymph, and adult do not greatly differ from one another in external appearance.

Treatment.

1. This pest is very difficult to combat because the extremely tiny mites feed not only on the outside of the bulb, but between the leaf scales of the bulb, feeding and laying their eggs in the interior, where they can scarcely be reached. The best plan is to burn badly infested bulbs, for the mites which have penetrated into bulbs cannot be reached. Infested soil should not be used for other bulbs.

2. In the case of mites which are more external the bulbs should be sprayed with paraffin, the treatment being repeated a fortnight later; or the bulbs may be washed in potassium sulphide (liver of sulphur), 1 oz. to 1 gallon of water, or brushed with this solution after removal of the outside scale leaves. This treatment is useful against fungi which follow the attack of the mite.*

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* At a meeting of the Scientific Committee of the Royal Horticultural Society (see *Gard. Chron.*, Dec. 20, 1902, p. 465) Mr. Saunders, in the course of a report on hyacinth bulbs containing a large number of *R. echinopus*, stated that "When bulbs are thus infested with these mites nothing can be done to save them. When only a few mites are at the base of the bulb, where the attack generally commences, they may be killed by immersing the bulbs for five minutes in water at a temperature of 115° to 120° Fahr. If some sulphide of potassium (6 ozs. to the pint) be added to the water, this remedy would be all the more efficacious; indeed it is said that soaking the bulbs in this solution cold for twenty minutes will kill the mites."

3. Infested bulbs may be fumigated with carbon bisulhide. The bulbs to be treated should be placed in an ir-tight receptacle, and a saucer containing the bisulphide f carbon should then be placed on the top of them, and the eceptacle closed. The bulbs should be left in the vapour or forty-eight hours. This treatment could be usefully xtended to imported bulbs, which ought to be examined or the mite. The formula for fumigation on the larger cale is one pound of bisulphide of carbon to 1,000 cubic eet of space, more being used if the infestation be very bad r if there be some leakage. Bisulphide of carbon fumes re very poisonous, and should not be breathed, and no naked ight (the operator, for example, should not be smoking) must e brought near them.

Whitehall Place, London, S.W.1,
April, 1905.

Revised, January, 1908

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Potato Scab.

The Common Potato Scab or Brown Scab is one of the most widespread diseases affecting the potato, and is exceedingly abundant in small gardens and allotments, especially where potatoes have been repeatedly grown, and where ashes, lime, and other alkaline substances have freely been used. Scab is caused by a minute soil-organism which attacks the surfaces of the tubers and causes the production of dark scattered scabs, or large eroded patches which appear to have been worn away or gnawed. The scabs increase in size with the growth of the tubers, and they may in bad cases cover almost the entire surface.

Although not so serious as some potato diseases the losses caused by scab are not by any means as insignificant as might at first sight be imagined. As a commercial article the tubers are rendered unsightly and their market value is considerably depreciated. The consumer also suffers as, owing to the deeper peeling which is necessary, there is excessive waste of the best part of the potato.* Further, affected tubers when stored are liable to decay or to be attacked by fungi. For eating purposes, however, the sound part of a scabbed tuber is not injured.

Causes of Scab.

In spite of the many investigations which have been carried out on brown scab it is only comparatively recently that its true nature has been clearly defined. The scab know as Oospora scab has long been regarded as general in this country, but great confusion existed in the literature owing to the fact that much of the ordinary brown scab had been often attributed to mechanical injury, or to the effect of various irritating substances in the soil. It is now known that these substances are merely influences assisting and not the primary cause, and that the Oospora scab and the common brown scab are one and the same thing, and that they are due to a bacterium known formerly as *Oospora scabies*, but now more correctly referred to the genus *Actinomyces*.

The method of attack has been carefully studied by American botanists. The organism may infect the tubers at any stage of their growth, from mere buds to fully grown tubers. It does not, however, attack potatoes after they are ripe or in storage, and when once the tubers are lifted they

* *See* Special Leaflet No. 67 (*Economy in Using Potatoes*).

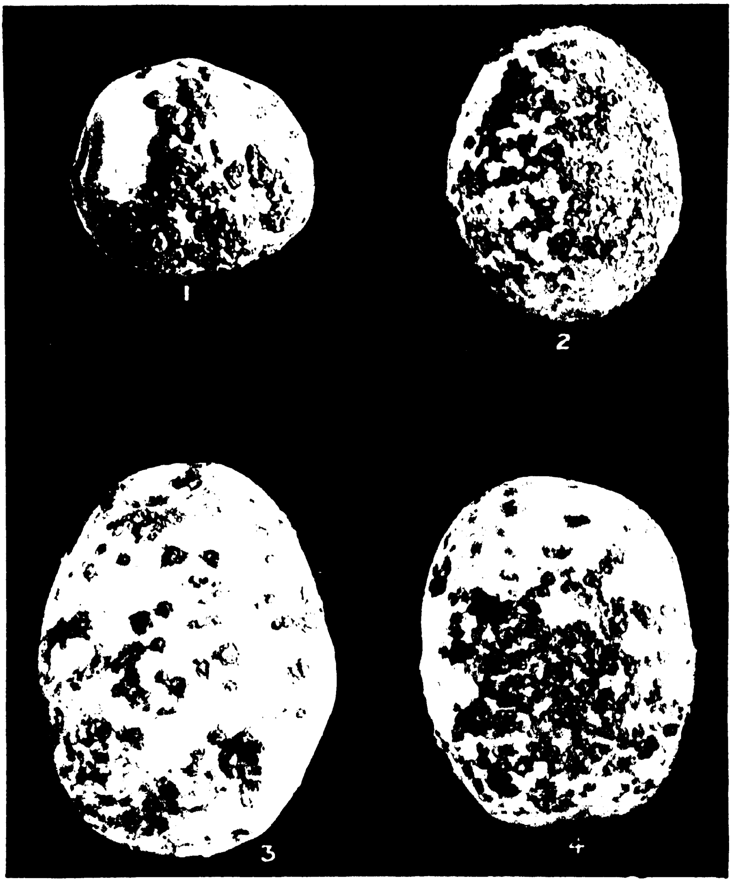
are free from further infection. The scabs first appear as small brownish spots and very frequently at the lenticels (the breathing pores which are visible as dark specks on the skin of the tuber). They increase gradually in size and depth, and vary considerably in their extent and appearance. These differences do not represent distinct kinds of scab, as has been sometimes supposed, but are largely due to the surrounding soil-conditions and the variety of the potato. The scab itself consists of a mass of corky tissue which is formed by the potato tuber as a result of the irritating action of the bacterium (fig. 1). It is an attempt on the part of the plant to exclude the invading organism, and it is successful in so far that it confines the parasite to the surface layers and preserves the inner tissues from attack. In the later stages much of the corky tissue falls away and the open scabs, so familiar on digging in autumn, are left (Figs. 3 & 4). An old dried tuber badly scabbed is shown in Fig. 2.

The scab organism is very widely distributed in garden soils, but it only becomes parasitic and attacks the potato when the soil conditions are such as render it specially active. The recent application of lime, lime-rubble, ashes, and even farmyard manure tend to render the soil alkaline or at least neutral, the condition which favours the virulence of the scab organism.

It is possible to show by simple experiments that soil which has been disinfected and does not contain the scab organism will not produce scabbed potatoes from clean seed, however full of ashes, road sweepings or other irritating matter it may be.

Although the scab-organism is especially abundant in humus and farmyard manure, and in gardens and allotments which have been long cultivated, it is believed to be exceedingly widely distributed and to be a normal inhabitant of the soil in almost all parts of the world. In all probability also it performs a useful function as a decomposer of organic matter. It is therefore clear that remedial measures should aim at preventing those chemical and other conditions of the soil which tend to make the scab-producing organism actively parasitic. In the past, sterilisation of the "seed" has been much advocated, but in view of the abundance of the organism in most soils, this treatment, except in special cases, would not appear to be of much value. Badly scabbed "seed" should, however, not be planted, as by its use, not only is a known virulent strain introduced in the very spot where it is not wanted, but such tubers are often of poor germination-capacity, and consequently yield a poor crop.

The only other plant which is known to be seriously attacked by the scab-organism is beet, which in some districts is liable to be badly scabbed. Some writers, however, believe that turnip and radish may be also affected.



ORDINARY OR BROWN SCAB.—Fig. 1 represents a young tuber freshly dug from the soil showing the scabs in their early stages. Figs. 3 and 4 show later stages, flat open scabs, as commonly seen on digging in autumn. Fig. 2 represents the appearance of a badly scabbed tuber when throughly dried.

(For the use of three of these photos the Board are indebted to the Department of Agriculture and Technical Instruction for Ireland.)

Other Scabs.

Certain animal-injuries such as those produced by millipedes, and possibly wireworms, may at times resemble brown scab. In the absence of the animal concerned it is not always possible to state the exact cause, and hence such damage has for convenience sometimes been spoken of as "mechanical injury." The disease known as Corky Scab is a perfectly distinct malady and is caused by the organism *Spongospora subterranea* (*see* Leaflet No. 232).

Control.

1. The most important preventive measure is treatment of the soil. The organism thrives in alkaline soils, and in those rich in humus, and hence the application of lime, ashes, and soot, and also farmyard manure, should be temporarily suspended in soils where scabbing is prevalent. Alkalinity of the soil may be counteracted by the use of superphosphate of lime and sulphate of ammonia. In small gardens and allotments a dressing of flowers of sulpher at the rate of 1 oz. per square yard should prove beneficial. Its effects, however, may not be fully noticeable the first season.

2. If possible scabbed tubers should not be used for seed. If they must be used, and if they are at all seriously scabbed, they should be disinfected by steeping for two hours in a weak solution of formalin (40 per cent. formaldehyde). Half a pint of formalin to 15 gallons of water is a suitable strength. The germination-power of badly scabbed tubers is poor, and hence these should never be used as seed, even after disinfection, unless absolutely necessary.

3. Scabbed potatoes and peelings from affected potatoes must not be thrown on the manure heap, neither should they be given to pigs unless they have been previously boiled.

4. Crop rotation is always a commendable practice and should be adopted as far as possible even in small gardens. As a preventive for scab, although it cannot be regarded as altogether effective, it doubtless assists in keeping in check a special potato-attacking strain of the scab organism. Beet also should be excluded from the rotation in badly infected land.

Whitehall Place, London, S.W.1,
March, 1905.
Re-written, June, 1917.

Copies of this Leaflet may be obtained free of charge, and post free, on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Sq., London, S.W.1.

Leaflet No. 138.

BOARD OF AGRICULTURE AND FISHERIES.

PINE WEEVILS.

Many members of the family of Weevils (*Curculionidæ*) are most harmful to vegetation, not only in the garden and field, but in the forest. In connection with forestry the most injurious species are *Pissodes notatus*, *Pissodes piniphilus*, *Pissodes pini*, and *Hylobius abietis*. Of the first three of these, *P. notatus* is the most frequent cause of complaint, whilst *H. abietis* is one of the most grievous pests in forestry.

The Banded Pine Weevil (*Pissodes notatus*).

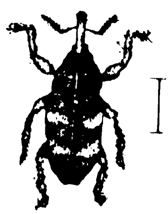


FIG. 1.—*Pissodes notatus*.
(The line on the right shows natural size.)

FIG. 2.—LARVA.
(Magnified.)

This weevil is injurious both as beetle and as larva. The beetle in feeding pierces the bark with its rostrum or snout right into the cambium and the innermost layers of the wood; the larvæ or grubs tunnel between the wood and the bark, and the result of bad infestation is the death of the plant.

Plants Attacked.

The favourite breeding places are young pines from three or four up to eight years of age, but trees in the pole stage are also infested. The favourite host plant is Scots Pine (*Pinus sylvestris*), but in Britain the weevil has also been found in Austrian Pine (*P. austriaca*) and Weymouth Pine (*P. strobus*). It also breeds in pine cones. There are Continental records of attack on Spruce and Larch, but this is exceptional. Whilst amongst older trees the weak and sickly will be chosen for egg-laying, the thinner branches of sound trees and any part of the stem or branches of a young pine may be used.

Signs of Attack.

(*a.*) Little snout punctures, as if the bark had been pierced here and there by a needle.

(*b.*) Bead-like drops of resin issuing from these punctures.

(*c.*) Drooping of the plants, with a reddening of the needles.

(*d.*) At a late stage of the larva's work in young or smooth-barked parts, little risings on the bark may be felt by the fingers, or little ridges may be seen; these mark the position of larval tunnels or pupa beds.

Description.

The *beetle* (Fig. 1) is red-brown in colour, and measures up to ⅜ in. in length; both upper and under surfaces are powdered with white scales. On the upper surface of the prothorax are four well-marked white points, and a fifth on the scutellum. The wing-covers have two transverse yellowish or whitish bands of scales, one in front and one behind their middle; the front band is non-continuous at the meeting place of the wing-covers, whereas the hind one is continuous right across the wing-covers.

The *larva* (Fig. 2) is a fleshy, somewhat wrinkled, curled, legless grub, with a brown scaly head and strong gnawing jaws.

Life-History.

The female after copulation lays her eggs in punctures made in the bark. From these hatch out grubs, which make galleries between the bark and the wood. If pines in the pole stage be chosen then several eggs may be laid near one another, and the galleries, owing to the sufficiency of room at the disposal of the grubs, show a star-like pattern; in young plants, however, the larvæ tunnel downwards or upwards. A trail of brown bore-dust marks the path of the grub, which, on being fully fed, gnaws out a bed in the outer wood-layers at the end of its gallery. In this hollowed-out bed, protected by a cover of sawdust and wood chips, the pupal stage is passed. The beds (Fig. 3) may be made all down the stem of the young pine, and also for an inch or two below ground. A very favourite place is immediately below the whorl of branches, where, in an infested plant, one is almost sure to find several beds clustered together. The yellowish-white coloured pupa gradually darkens into the beetle, and this when ready to issue bores a circular hole through bed cover and bark.

The generation is typically an annual one. MacDougall has shown* that the *Pissodes* have a remarkably long life in

* Proceedings of the Royal Society of Edinburgh, Volume XXIII.

the adult stage, and that those beetles which have bred in one year may, after hibernation, proceed anew to egg-laying. In his experiments two females lived in the imago or adult stage two years, and a male for three. Adult beetles may be met with from April (March in a favourable season) onwards to the end of September, and egg-laying may take place at any time during this period.

Preventive and Remedial Measures.

1. Where the beetles have not yet got a footing a timely and a vigorous rooting out of all suppressed or sickly pines will go far to prevent injurious attack.
2. Where the beetles occur in numbers, collecting them would be a useful measure; this plan could be adopted in nurseries with good results.
3. The great means the forester has in proceeding against this pest once it has got to work is the preparation of catch-trees or decoy stems. These consist of sickly plants or trees

FIG. 3.—YOUNG PINE KILLED BY P. NOTATUS. BARK REMOVED TO EXPOSE PUPAL BEDS WITH EXIT HOLES. (Two-thirds natural size.)

əft here and there in nursery or plantation; or plants may ·e artificially weakened and left standing, or an older tree ɑay be cut down and allowed to lie as a place for breeding ɑ. In consequence of the long-continued life and egg-laying, uch trap plants must be arranged, and visited and renewed t intervals through the year, from March till October. Each rap might remain for two months, when young trap plants hould be destroyed, or older ones barked and the exposed arvæ destroyed. Natural aids will be forthcoming from ›arasitic *Ichneumonidæ*.

The Large Brown Pine Weevil (*Hylobius abietis*).

This insect is in our country the cause of the dying away ›f young coniferous plants, acres of which may have to be ·e-planted because of the weevil attack. The larvæ or grubs ive in the stumps and roots of felled conifers, and therefore lo little actual harm; the harm is done by the adult beetles, vhich gnaw the bark of the stems of young plants (Fig. 6) ›nd the younger shoots of older plants.

Plants attacked.

The plants attacked by the adult are Scots Pine, Weymouth ?ine, Spruce, Larch, Japanese larch, Silver fir, and Douglas ir. It is characteristically a conifer pest, but if the coni- 'erous crop be not pure, but mixed with broad-leaved species uch as Oak, Alder, or Birch, these latter may also be attacked.

Signs of attack.

(*a.*) Pieces may be bitten away here and there all down he young plant. The damage may extend as far as the ambium layer. Very young plants may be more or less ompletely barked.

(*b.*) Drops of resin (Fig. 4) may be found exuding from the wounds. These drops dry into rough masses over the stem.

(*c.*) The dying off of attacked plants.

Description.

The *beetle* (Fig. 5) measures up to half an inch in length. It has a marked proboscis, with the kneed-antennæ springing from near its apex. The colour is dark brown, with yellowish or golden hairs or scales on various parts of the body, but these are specially marked on the wing-covers, where they form bands; in old beetles, the scales may have been rubbed off.

The *larvæ* (Fig. 7) are yellowish-white in colour, legless, with brown heads and biting jaws; they have a curved form, and when full grown measure up to half an inch in length.

Life-History.

The beetles choose as their favourite places for egg-laying the stumps and thicker roots (exposed or below the surface)

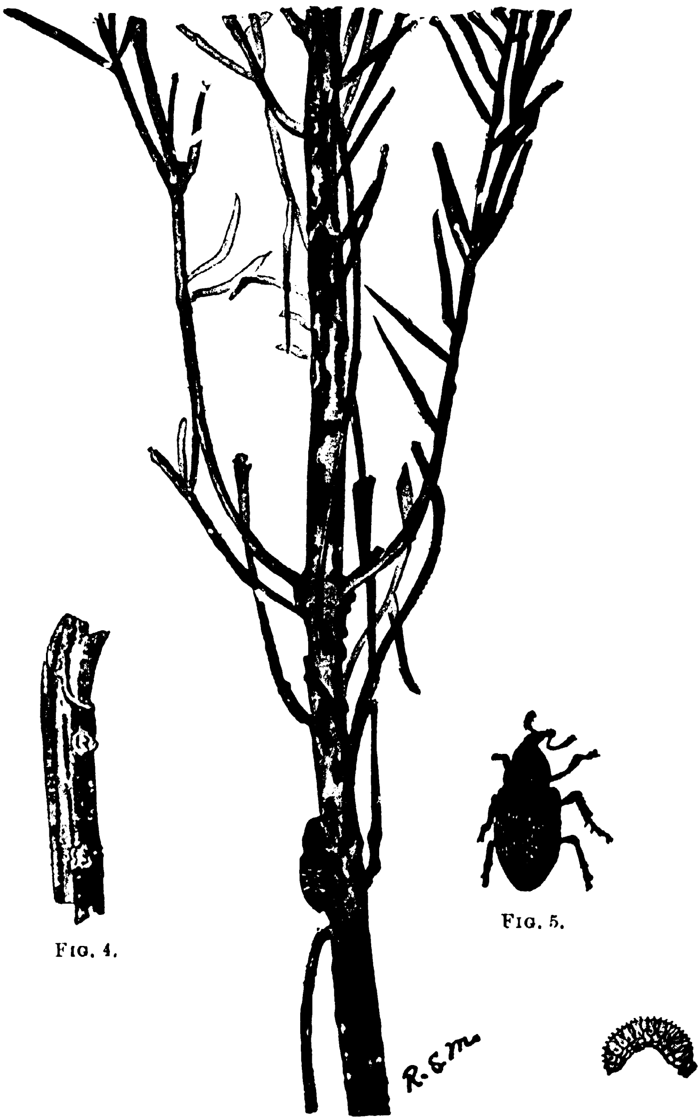


FIG. 4. FIG. 5. FIG. 6. FIG. 7.

FIG. 4.—ATTACKED STEM, showing drops of resin exuding from the wounds. FIG. 5.—*H. abietis* (magnified). FIG. 6.—YOUNG DOUGLAS FIR KILLED BY WEEVIL; WITH WEEVIL FEEDING (natural size). FIG. 7.—LARVA OF *H. abietis*.

of felled pine and spruce. The eggs are laid singly, and the grubs on hatching gnaw long tunnels (Fig. 8) between the wood and the bark, these tunnels increasing in width with the growth of the grub; behind the grub the tunnels are filled with frass from the boring. When full grown the grub gnaws out a bed (Fig. 8) in the youngest wood layers, and here, under a cover of sawdust and wood chips, it may lie a long time (larvæ full grown in autumn may lie as unchanged larvæ till the next May or June) before passing into the pupal stage. The pupal stage in May or June lasts about three weeks, and the beetles issue by a round hole bored through bed cover and bark.

The adult beetles are long-lived, and Von Oppen has shown that thay can live during a season, and after hibernating can proceed anew to pairing and egg-laying. Thus in the early summer the following generations of beetles may be found at work:—(1) some of the egg-laying beetles of the previous year, which, after hibernation, continue their egg-laying; (2) beetles which had completed their development in the previous autumn but too late to proceed to reproduction; and, (3) beetles newly adult, which having passed the winter as larvæ or pupæ have developed into the adult during the warm weather of spring or summer.

The point of great practical importance is that there is no limited swarm period, but that beetles may be found at work feeding and reproducing during all the warm months of the year.

Preventive and Remedial Measures.

1. Removal from the felled area of stumps and roots, so as to deprive the beetles of breeding places.

2. The stumps and roots may be left to serve as places for egg-laying, but they must be grubbed up and burned, in order to destroy the enclosed brood before development has reached the adult stage.

3. Avoid having breeding places and feeding places side by side or near one another, *i.e.*, avoid cutting and planting areas in regular sequence. The longer the time elapsing between felling close to a newly-planted area the better. Much can be said for the practice of allowing stumps and roots which are left in the ground to decay before planting the area.

4. It is often recommended to make trenches, to prevent the beetles from reaching a newly-felled area for egg-laying, or to isolate a clean, newly-planted area. The trenches, a foot deep and 8 to 10 in. wide, should have steep sides and be clear of rubbish, and the beetles which fall into them must be collected every day and destroyed. Opinions differ

as to the value of such trenches. Experience shows that they may easily fail as traps, as the beetles can fly over them.

5. Branches of pine and spruce a yard long and 2 to 3 in. in diameter thrust into the soil on felling areas are used by the beetles as places for egg-laying. After some months these can be visited and barked so as to destroy the brood.

6. Experience shows that *the most efficient means of trapping* the beetles is to lay here and there on the ground in newly-cleared and infested areas pieces of fresh Scots pine bark, 8 to 12 in. long by 4 to 6 in. wide. These should be laid on the surface (not below it), with their outermost surface

FIG. 8.—ROOT OF SPRUCE WITH BARK REMOVED, showing tunnels of grub, bed of pupa, and hole into wood made by full grown larva.

upwards. The beetles collect on the under surface for feeding. These traps must be regularly visited, and the beetles destroyed, either by dropping them into boiling water or into a vessel containing paraffin. The traps must also be often renewed, as when they dry and lose their odour they cease to attract. In Scotland, thousands of beetles have been caught by these means.

It is of the utmost importance to proceed against *Hylobius* in its breeding places, and not wait till the beetles have started to feed on the young plants.

Whitehall Place, London, S.W.1,
April, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 139.

BOARD OF AGRICULTURE AND FISHERIES.

A Mushroom Disease (*Hypomyces perniciosus*, Magn.)

DISEASED MUSHROOMS.

During certain seasons cultivated mushrooms are destroyed in a wholesale manner by this disease, not merely in this country but also on the Continent; more especially in the

neighbourhood of Paris, where mushroom culture is conducted on a very extensive scale. The primary cause of the mischief is a minute parasitic fungus, which when once introduced, spreads very quickly under the conditions of temperature and moisture essential for the rapid growth of mushrooms.

Description.

Well-marked symptoms are evident from the earliest stages of disease, the mycelium of the parasite growing up with that of the mushroom. The latter, instead of gradually developing into a cap and stem, becomes an irregularly-shaped monstrous soft mass, which if allowed to grow, often exceeds in size that of a full-grown mushroom. Sometimes a small, deformed cap is present, but as a rule the entire mass of a diseased mushroom consists of a much swollen stem. After a time the parasite forms its spores on the surface of the diseased mass, appearing under the form of a snow-white, minutely velvety covering. After the spores are scattered the diseased mushroom rapidly decays, forming a putrid mass having a very disagreeable pungent smell.

Remedial Measures.

Numerous toadstools and other fungi suffering from the parasitism of different kinds of *Hypomyces* are common in our woods and pastures every season, and spores are probably introduced into the mushroom bed along with the manure or road sweepings commonly used.

(1.) In some instances it is certain that the spawn is infected before it is placed in the mushroom bed. In such cases, when the spawn commences to "run," the threads, instead of having a clear and sharp outline like white cord, present a fluffy appearance, due to the presence of the parasite on the surface of the strands; the branches are also much fewer in number than when the spawn is healthy and growing vigorously.

Under such circumstances the entire bed should be removed before the parasite produces spores; otherwise, if the house becomes thoroughly infected, common experience has shown that the disease is exceedingly difficult to eradicate.

(2.) When infection occurs through the introduction of spores into the house by wind or other causes, the disease may be confined to certain portions of the bed, and the prompt removal of infected mushrooms as soon as the slightest symptoms are observed may check the disease from assuming the proportions of an epidemic.

(3.) After removing the soil and manure of an infected bed, great care should be taken in cleansing the tools, boots, and even clothing; otherwise there is great risk of infecting other beds. Rejected soil and manure should be at once

removed from the neighbourhood of the mushroom beds. They may be applied to the land, as the contained spores, so far as is known, can only develop on some kind of fungus, and do not attack any other cultivated crop.

(4.) When a house or other structure in which mushrooms are grown has become infected, it should be completely emptied and thoroughly sprayed, both roof, walls, and floor, three times at intervals of ten days with a solution of sulphate of copper—one pound of sulphate to fifteen gallons of water.

During this period of spraying the house should be kept warm and moist, for the purpose of favouring germination of the spores of the parasite, which are destroyed with greater certainty when growing than when in a resting condition.

Whitehall Place, London, S.W.1,
June, 1905.

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Leaflet No. 140.

BOARD OF AGRICULTURE AND FISHERIES.

The Felted Beech Coccus (*Cryptococcus fagi*).

Distribution.

This insect confines its attacks exclusively to the beech (*Fagus sylvatica*), and is one of the most destructive pests against which the arboriculturist has to contend. It is widely distributed throughout England, and has occurred in many parts of Scotland. It is common in the counties of Flint and Denbigh in North Wales; while in Ireland it has, so far, been recorded from one locality only. Its attacks are often restricted to a comparatively small area, or even to single isolated trees, this being especially noticeable where the tree-trunks are sheltered from the prevailing winds.

Signs of Infestation.

Owing to the whiteness of the felted covering with which the female protects its body, and also to its exposed position upon the trunks and main branches of the trees, the beech coccus is at all times a conspicuous species, and more especially so when the white secretionary coverings unite and almost completely cover the bark of the tree.

Young and old trees are alike attacked; and the insects usually confine themselves to the main trunk and larger branches; but the smaller branches, especially those of young trees, are sometimes infested to a serious extent: in a case recently recorded a beech hedge 13 to 14 feet high was here and there badly infested. Where the infested trees are growing in exposed situations the insects almost invariably select the sheltered side of the tree. Many badly infested trees which have been under close observation for the last sixteen years are still apparently vigorous and healthy, while others have been totally destroyed. The first sign of decay is usually seen in the foliage, which becomes discoloured and sparse or thin, accompanied by the death of the smaller branches; this is followed by the death of the larger branches and, finally, the tree trunk; while the bark peels off from the branches and falls away. Whether the work of destruction is aided by the joint action of a bacterial or fungoid disease is not at present known, but it is probable that such is the case.

Description and Life-History.

The beech coccus belongs to the generally destructive family of Scale insects (COCCIDÆ). *The adult female* is of a lemon-yellow colour, and measures about one twenty-fifth of an inch in length. It is both wingless and legless: is somewhat hemispherical in shape, being

flattish beneath and highly convex above ; and to the naked eye or under low magnifying power it appears like a small yellow egg. The mouth organs are placed on the underside of the body, and are composed chiefly of three hair-like appendages which in life are united to form a long sucking tube ; with this slender apparatus the insect pierces the bark and sucks up the juices of the tree. She has no power of locomotion, remaining stationary throughout life, anchored to the tree by her mouth organs, motionless and apparently senseless. Almost immediately after leaving the egg she covers her body with the white felted secretion, composed of fine filaments of wax, which gradually thickens and forms an excellent protection to her body, being practically impervious to rain. Within this covering the insect lives, lays her eggs, and dies.

The *larvæ* or "lice" as they are sometimes called, are very tiny active creatures, and are scarcely visible to the naked eye. They possess three pairs of legs and a pair of horns (antennæ), and, like their parents, are of a yellow colour. Although they can and do travel over the bark of the tree, they usually settle down in the immediate neighbourhood of the parent, the majority working their way under the bodies of their dying or dead parents, taking up their positions, by preference, in the deepest parts of the fissures in the bark, where they remain for the rest of their lives pumping up the juices of the tree. Each individual protects its body with secretion, which adds to that already secreted above them by the insects of the previous generations ; thus the secretion gradually thickens and spreads over the tree-trunk, forming a more or less continuous mass, often attaining a considerable thickness. Larvæ which wander over the bark are liable to be borne away by the wind or, inadvertently, by birds and insects, and this is undoubtedly the means by which fresh colonies are started.

The *male* is unknown in any stage, the females being parthenogenetic, reproducing their species without the intervention of the opposite sex.

Many of our indigenous Scale insects are subject to the attacks of minute parasitic insects related to the wasp family ; but, so far, the beech coccus has proved immune from their attacks. Birds do not appear to feed upon them.

Treatment.

Owing to the comparatively smooth nature of the bark of the beech, and also to the fact that the insects are often confined to the trunk and main branches, this pest is more easily accessible for treatment with insecticides than are many other pests. They are, however, so well protected by their waxy coverings that the application of an insecticide must be carried out in a thorough manner or the result will be anything but satisfactory.

FIG. 1.

FIG. 2.

FIG. 3.

Fig. 1.—Main trunk of young beech badly infested with coccus. Fig. 2.—Young beech, which was similarly infested to that shown in Fig. 1, 21 months after treatment with paraffin emulsion; now free from the pest. Fig. 3.—Upper branches of very old beech killed by the coccus; the bark has peeled off in patches.

1.—The trees should be sprayed, when in the dormant condition, with the following emulsion-soda wash, as used at the Woburn Fruit Farm:—Paraffin, 2 gallons; soft-soap, 1½ lb.; caustic soda (98 per cent.), 6 lb.; water, 28 gallons.

In order to prepare the wash the soft soap should be dissolved in a gallon of boiling water; the paraffin should then be added and the mixture churned thoroughly until a cream-like mass results. The thoroughness of the churning is important.

The 6 lb. of caustic soda should next be dissolved in the remaining 27 gallons of water and then poured into the paraffin emulsion. The whole should be well mixed and used immediately.

Recent experimental work at Woburn, however, indicates that there are advantages in using a wash composed of:—Sulphate of iron, ½ lb.; lime, ¼ lb.; paraffin (solar distillate), 5 pints; caustic soda (98 per cent.), 2 lb.; and water to make 10 gallons.

This may be prepared for use by proceeding as follows:—(*a*) Dissolve the sulphate of iron in about 9 gallons of water; (*b*) slake the lime in a little water, and then add a little more water to make it into a "milk"; (*c*) run *b* into *a* through a piece of coarse sacking to remove grit; (*d*) pour the paraffin into the mixture *c* and churn the whole thoroughly; (*e*) add the caustic soda in powdered form just before using, and stir thoroughly.

In using either of these mixtures the face and hands must be protected, as the mixtures are caustic in character.

One advantage of the caustic soda is that it helps to clear the tree of such growths as lichens and algae.

2.—On a trunk which is clean save for the Felted Beech Coccus paraffin emulsion would prove satisfactory.

Even with the most careful spraying there would be crevices and protected places in the bark that would almost certainly not be reached, and for such places a good scrubbing brush with stiff bristles—wire bristles are good—should be used. The brush should be dipped in the wash and the spots referred to scrubbed.

In dealing with an isolated infested tree, or with a few trees only, brushing would be more effective than spraying, and once the treated trees are clean they should be kept under observation, so that any places showing new or increased infestation could be brushed over.

Whitehall Place, London, S.W.1,
May, 1905.
Revised, June, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 141.

BOARD OF AGRICULTURE AND FISHERIES.

The Preparation of Honey for Market.

Qualities of Good Honey.

The bee and honey classes of the shows now held during each season, both in London and the country, have taught the consumer what to require in a first-class honey, but it remains none the less true that it is often difficult to obtain remunerative prices for honey. Before bee-keeping is embarked in on a large scale, therefore, arrangements for marketing the produce should be made. Comb-honey (in section cases) should be translucent, showing the clear bright colour of the contained honey, evenly and delicately worked out to the sides and bottom of the section, and with a scrupulously clean surface. The finest liquid extracted-honey should be bright and clear, of a light straw colour, and delicate in flavour and aroma. Granulated extracted-honey should be of fine, even grain, creamy white in colour, and of good flavour. There are many grades of medium and dark-coloured honeys below this first-class standard, but the latter is what the bee-keeper must strive to attain, in order to command a ready sale for his produce.

Preparation for Comb-Honey in Sections.

In regard to comb-honey, the preparation commences with the fitting of the wax foundation in the sections. To ensure a well worked out section this should be cut so as just to clear the sides of the wood and hang to within one-sixteenth of an inch of the bottom, thus allowing for a slight stretching of the foundation caused by the heat of the bees clustering on its surface. The fitted sections must next be placed in the section rack, with separators between the rows, reaching to within three-eighths of an inch of the top and bottom, and wedged up perfectly square and tight; this is important, for the bees will place *propolis* over every crack or small space, causing disfigurement and extra work in cleaning; also sections "out of square" are much more liable to breakage when packed for travelling, owing to the unavoidable spaces between them. The rack must be placed perfectly level on a hive containing a strong colony of bees; it will then be filled with good, straight, and even combs.

Removing filled Racks.

Removing filled racks from the hives should be done with as little disturbance to the bees as possible; the best method is to (1) place a "super-clearer" on a stool or box by

the side of the hive, raise up the bottom edge of the rack and insert a small wedge; (2) puff a little smoke between the rack and tops of the frames, remove the rack steadily with a screwing motion, and put it down gently on the "super-clearer"; (3) place a cloth, on which a few drops of carbolic acid have been sprinkled, over the top of the frames; (4) in about ten seconds remove the cloth, and it will be found that the bees have been driven down, leaving the tops clear; (5) then immediately take up the rack with the "super-clearer" and place it on the frames. If this operation is carried out in the afternoon, by next morning every bee will have found its way down to the body of the hive through the bee-escape in the centre of the "super-clearer," and the rack can be removed with comfort to the bee-keeper and without disturbance to the apiary.

The full racks should be carried into a bee-proof room, the wedges and back-board removed, and the centre section of the exposed row taken out. It should not be lifted straight out, as the result would probably be a damaged section, but if tilted backward on its bottom edge, it will loosen and come away easily, as also will the two side ones. The sections should be sorted as they are taken out, placing all well-filled clear ones in the first grade; those not well-worked to bottom and sides, and therefore not fit for travelling, will make a second grade; and any only partially filled must be given back to the bees to finish, unless the "honey-flow" has ceased, in which case they must be emptied by the extractor (*see* p. 3). All propolis must be carefully scraped from the edges of the sections, which, if not already sold, should be stored in a dry, warm cupboard, and protected from dust by tying them in packages of four or six in clean paper; care must be taken not to place anything having a strong odour near the honeycomb, or it will spoil the flavour of the honey.

Packing Sections.

If the sections are sold to wholesale dealers for re-sale to traders, no further preparation is needed. To pack them so as to travel safely, not more than from four to six dozen, preferably the smaller quantity, should be put into one package.

Packing may usefully be done as follows:—(1) Procure a strong wooden box, bore two holes in each end, about one-third down, and knot firmly into them rope handles, by which the box can be safely and easily lifted; (2) in the bottom of the box put a bed of straw, and on this place, quite close together, a layer of the wrapped-up packages of sections, leaving at least two inches between the sides of the box and the sections: this space must be filled with straw, tightly pressed in, and, to prevent possible damage to the comb, the ends of the packages may be protected by pieces

of straw-board or thin wood; (3) continue with layers of packages, filling in round the sides as before until within two inches of the top; (4) then fill up tightly with straw, and *screw* on the lid. Packages should be plainly labelled: "Comb-honey, With Care." Retailers of honey-comb prefer to have the sections sent to them glazed, the comb being thus preserved from injury by careless handling, and, what is still more important, kept free from the dusty impurities unavoidably present in shops.

Glazing the Sections.

For glazing sections, glass cut to the correct size may be purchased of any dealer in bee appliances, together with the strips of paper lace edging, which, when pasted round the angle formed by the glass and wood, serve to fix the glass on. In country towns the local glazier will gladly cut up waste glass to the small size (viz., $4\frac{3}{16}$ in. by $4\frac{3}{16}$ in.) required, while neatly printed bands of coloured paper, 19 in. by 3 in., can be used instead of the lace edging. These bands cost about 7s. per 1,000. They are more easily pasted on than the paper lace edging, and make much firmer and neater work, while they also give an opportunity of placing the names of the apiary and retailer on each section. Neat card-board cases, plain or glazed on one or both sides, can be purchased cheaply from appliance manufacturers.

"*Extracting*" *Honey.*

"Extracted" or "run" honey has been greatly improved in quality by the modern method of obtaining it; and the use of the centrifugal extractor compels the abandonment of the skep system of bee-keeping, with its waste of bee life, waste of combs, and taint of sulphur. This method also necessitates the adoption of the frame hive, which enables the gathered surplus to be stored in frames apart from the brood-nest and to be removed at will by the bee-keeper.

Honey improves in flavour and density while ripening in the hive, therefore the shallow frames should not be removed until the honey is well sealed over. The full sealed frames of comb having been carried into the store-room, they should be sorted by holding them up to the light, and all those containing dark or second quality honey may thus be separated from the better ones. Fermentation is the great enemy of extracted honey, but it can only affect badly ripened honey or honey exposed to moisture and warmth; if therefore it should be necessary to extract unripe honey, it should be returned to the bees for re-storing and ripening.

Extraction is done by means of a machine consisting of a tinned-iron can, within which is a vertical spindle carrying a pair of cages to hold the frames of honey-comb and made to revolve rapidly by means of a simple hand-gear. Before placing the frames of comb in the cages they must be uncapped. To do this quickly and without waste

special uncapping knives are used; they should be heated in a tin of water kept hot over a small spirit or oil lamp. The full frame, held by one lug in the left hand, the other lug resting on a large dish and with the top edge overhanging, has its capping removed with the sharp, hot knife by a gentle, slightly sawing, downward cut, passing just beneath the surface and removing as little as possible of the honey. If held with sufficient overhang the detached sheet of capping will fall clear of the frame. A pair of frames having been uncapped they are placed in the cages of the extractor and made to revolve rapidly with their bottom bars leading; the centrifugal force throws out the honey, and when one side has been emptied the frames are reversed and the other side treated in the same manner.

Packing Extracted Honey.

After uncapping and extracting the contents of the best combs, the honey should be strained through a bag made of muslin in order to remove all loose particles of wax. Tin cans, with strainer and honey tap, made to contain 56 lb. or 112 lb., can be obtained, in which, if the honey is allowed to stand for twenty-four hours after straining, it will be freed from air bubbles, and can then be drawn into whatever jar, or tin will best suit the local market. Best honey is usually put into 1 lb. or ½ lb. glass jars, with metal screw caps having a cork wad inside the cap. To prevent any leakage the cork wad should be dipped in melted wax and placed on the jar while still warm, the cap being screwed down upon it. A neat label (of which varieties are obtainable from appliance makers or from the Secretaries of many of the County Bee-keepers' Associations) will set off the honey jar and make it more attractive. The darker honey is more suitable for marketing in its granulated state; when extracted and strained it should be run into 14 lb. or 28 lb. tins, the contents of these being stirred gently, now and again, while granulating; the stirring tends to produce a more even and finer grained honey. It may also be run into wide-mouthed glass or earthenware jars, covered down with parchment paper, and stored in a cool, dry place. Dark and coarse-flavoured varieties may be sold for manufacturing and confectionery purposes, or for that now almost forgotten process the making of mead.

Whitehall Place, London, S.W.1,
May, 1905.
Revised, February, 1911.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 142.

BOARD OF AGRICULTURE AND FISHERIES.

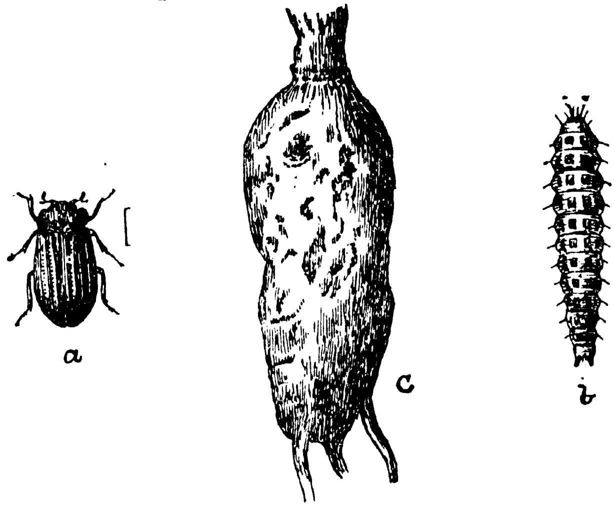
Calf Rearing.

This Leaflet has been temporarily withdrawn:
See statement in Prefatory Note.

Leaflet No. 143.

BOARD OF AGRICULTURE AND FISHERIES.

The Turnip Mud-Beetle (*Helophorus rugosus*).



HELOPHORUS RUGOSUS.—*a*. Beetle, magnified, with line showing nat. size. *b*. Larva, magnified (after Ormerod). *c*. Turnip, showing gnawings of grub.

The Turnip Mud-Beetle (*Helophorus rugosus*) belongs to a family of beetles the life histories and food habits of many of which are imperfectly known. The best known members of the family are aquatic, both as adults and as grubs, and the grubs may be vegetable feeders or they may be carnivorous. The species of the genus *Helophorus* are non-swimmers, although they can be found on water, near water, and in mud. They are capable of flight, and species have been found away from water on herbage.

Distribution.—As to the distribution of *Helophorus rugosus*, Fowler describes it as "rather local, but widely distributed through England and Wales inland and near the coast, not so common in the north; Scotland, scarce: Lowlands, Tweed, Forth, Solway, and Dee districts." Up to 1905, so far as is known, all the complaints made as to the destructive work of this beetle came from Aberdeenshire. In 1906, however, the insect was reported to the Board as having done considerable damage to turnips on a farm in North Lincolnshire, and the attacked turnips were described as "stunted in growth, hard and woody, and full of galleries." Again in November, 1912, the grubs were found damaging several large patches of turnips at Chichester.

Method of Attack.—(1.) The leaves may be eaten. (2.) The leafstalks may be holed and tunnelled. (3.) The swollen "bulbs" may be irregularly gnawed and tunnelled on the outer surface, especially in the upper part.

The harm is done by both beetle and grub. A favourite place for the pests is at the crown of the turnip sheltered amongst the leaf bases, the young leaves being destroyed as they come forward. Attacked leaves curl up, and attention may be drawn to the presence of the pest by the curled leaves standing straight up from the "bulb" and close together. The holes made in the "bulb" afford entry to rain and fungus enemies, and the plants may die off.

Description.

Beetle.—The adult insect measures about one quarter of an inch in length; it is oval, oblong, and somewhat broad. The colour is dark reddish, but the redness may be obscured by a covering of mud. The thorax is irregularly ridged and knotted, with its front angles prominent. The wing-covers show here and there dark markings; between the longitudinal ridges of the wing-covers are rows of punctures. The legs are pale red, and the antennæ of the beetle are somewhat thickened towards the top.

Grub.—The appearance of the magnified grub is well shown in the illustration. The dark coloured head has brownish jaws. The three segments behind the head each carry a pair of legs; on the upper surface of these thoracic segments is a dark transverse curved line, whilst down the back of the remaining segments there are two rows of large square spots, with rows of smaller spots below down each side. The body ends in two processes. Some grubs sent to the Board of Agriculture and Fisheries early in October, 1904, were over one quarter of an inch in length, and were not full-fed. The pupa like the larva has two spines at the end of the body and hairs projecting from the sides.

Remedial Measures.

It is strongly recommended that, as far as is practicable in the rotation, turnips should be sown at a distance from a field that has been infested. In fighting the pest the most successful measure has been the application to the crop of stimulating dressings; 1 cwt. of nitrate of soda per acre proved satisfactory on that portion of the field least infested. As pupation takes place in the soil a deep ploughing should follow attack.

Whitehall Place, London, S.W.1,
June, 1905.

Revised, February, 1913.

11397 K

Leaflet No. 144.

BOARD OF AGRICULTURE AND FISHERIES.

Heart Rot of Beet, Mangold and Swede
(*Sphaerella tabifica*, Prill. et Del.).

Yellow Globe Mangold, showing Heart Rot.

This disease is not uncommon in France, where it often causes considerable damage to sugar beet. In this country it has of late years been frequently reported on the mangold and swede. An instance recently occurred where nearly every root grown on a four-acre plot of "Yellow Globe" mangold was badly diseased. At the time of its discovery workmen were busily engaged in cutting off the sound

portions for cattle food, and chopping up the diseased parts and scattering them over the land to be ploughed in.

Description and Appearance of Plants Infested.

The disease rarely appears before the middle of August, and first attacks the stalks of the largest leaves. Its presence is indicated by the wilting of the leaves, such as follows a hot, dry day; diseased leaves, however, do not recover their erect position during the night, but remain lying on the ground, turn yellow, and decay. This is due to the fungus growing in the leaf-stalk having choked the vessels and thus prevented the passage of water into the leaf. When the leaf is dying, whitish patches of variable form and size, bounded by a dark line, and studded with minute black spots, the fruit of the fungus, appear on the leaf-stalk. Similar patches are also sometimes present on the leaves. Later in the season, when the leaf-stalks are dead and dry, a second form of fungus-fruit appears on the bleached patches.

Some time after the leaves have been infected the mycelium of the fungus passes into the crown of the root and thence gradually extends downwards, its progress being clearly indicated by a darkening of the tissues. The entire root is finally reduced to a blackish, decayed mass.

Preventive and Remedial Measures.

(1).—If a portion of a diseased root, which is crowded with the mycelium of the fungus, is kept until the following season, it undergoes no change until about midsummer, when its surface becomes covered with the fruit of the fungus. Such fruit furnishes the spores that infect a crop in the first instance.

When diseased roots are left on the land the same thing happens. If the disease appears, as indicated by the symptoms described, it is best to lift the crop at once before the fungus passes from the leaves to the root.

(2).—Diseased leaves and roots should be gathered and burned, or deeply buried, and should not be thrown on the manure heap or left on the land.

(3).—Yellow varieties of mangold are more susceptible to the disease than red ones, as proved by infection experiments. Red varieties might, therefore, be grown where the disease has already occurred.

Whitehall Place, London, S.W.1,
April, 1906.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

11397 K 2

Leaflet No. 145.

BOARD OF AGRICULTURE AND FISHERIES.

Sheep Dipping.

Sheep scab and the effects of dipping on the parasite causing this disease are dealt with in Leaflet No. 61. Dipping, however, is recommended for the destruction of certain other parasites, such as Keds and Lice.

The Ked (*Melophagus ovinus*).—This pest, often wrongly called "the tick" is probably the most widely distributed of the parasites which attack sheep. It is a member of the same order (*Diptera*) as the house fly, but is wingless. It is about ¼ inch in length, has a compressed leathery body, brown-grey in colour, and covered with short hairs. The Ked does not lay eggs; these are hatched in the body of the parent insect and the maggot is nourished there. When the maggot is deposited development is so far advanced that it at once becomes a pupa under cover of the puparium. The brown pupal cases (*puparia*) may be found at the base of the wool fibres. Reproduction is slow, each female producing about three to five pupæ at intervals of a few days, after which it dies. Keds are for the most part spread by contact of one sheep with another. The mature creatures cause great irritation and loss of condition.

The Sheep Tick.—*Ixodes ricinus* and *Haemaphysalis punctata* are not true insects, but belong to the *Ixodidæ*, a family of the order *Acarina*. On hatching from the eggs ticks bear only three pairs of legs, but when mature they have four pairs. (True insects in the mature state have only three pairs of legs.) The eggs are laid in large numbers amongst damp herbage; the larvæ on hatching attach themselves to sheep or other animals and after feeding fall to the ground and moult, after which they become *nymphæ*. Again they reach a sheep and after feeding for a short time fall away and moult a second time, becoming adults. Once more they feed on the sheep as adults, and after gorging themselves with blood the females tumble to the ground for egg laying. When fasting they are flat, and move with ease, but the body of the female is capable of great distension and is very much larger when gorged with blood. The large ticks begin to be found on sheep about March, and reappear in autumn. They are notably common on the hill pastures of the Border districts and in the Western Highlands, though they occur also in other districts.

Lice.—Lice infesting sheep do considerable harm by cutting the wool and causing itching, irritation and unrest. The head of the louse is large and broad; the body is compressed and wingless. The louse is chiefly found on young animals or on animals in poor condition.

Maggots.—The larvæ of certain flies (especially the green-bottle *Lucilia sericata*) are a source of great trouble and loss to flock-masters during the summer months. The flies deposit their eggs in clusters amongst the wool, and the resulting maggots feed on the live flesh of the sheep. (For particulars of this pest *see* Leaflet 126.)

The operation of dipping is performed in a variety of ways, several types of bath being in common use.

The Hand Bath.

The simplest form of bath is made of wood, galvanized iron, or earthenware, and measures 4 feet in length and depth and 1¾ feet in width. In this the animal is immersed by turning it on to its back, and holding its head above water. The advantages of this form of bath consist in its low cost, and in requiring comparatively little liquid to fill it; while its disadvantages are (*a*) the unnatural position of the sheep and the consequent risk of poison "running" into its mouth and nose; (*b*) the laborious and slightly dangerous character of the work for the labourers; and (*c*) the danger of abortion to in-lamb ewes. The hand bath requires more men to work it than the swim bath.

A very convenient arrangement consists of a portable wooden bath 6 feet long, 2 feet 6 ins. wide, and 2 feet 3 ins. deep at one end, the exit slope commencing 3 feet from that end. The exit end is bolted to a specially built, crate-like tip-cart, into which the dipped animals walk to drip. The body of the cart is kept horizontal, the shafts being turned down to the ground, the whole being fixed. The sheep leave at the front end by walking down a slope fixed over the shafts. The whole outfit, not including wheels and axles, may cost about £6 10s. When not in use for dipping, the cart may be usefully employed as a closed conveyance for calves, sheep, pigs, &c. For a fuller account of this type of bath, together with illustrations, *see* the *Journal of the Board of Agriculture* for July, 1908.

The Swim-Bath.

The swim-bath is made in two forms, being either so narrow (under two feet) that a sheep can only swim forward, or so broad (3½ feet) that sheep can swim round in it. A bath much used on the larger pastoral farms in Scotland consists of a trough with sloping ends, 33 feet long at the top, 20 feet 6 ins. long at the bottom, and 5 feet deep. The width is about 20 inches, only allowing room for the sheep to pass through the bath in single file. The bottom of the trough is somewhat narrower than the top. The sheep are put in at one end, and after swimming through the bath, pass up the inclined plane at the other end to a dripping pen.

A permanent swim bath constructed of cement, or stone or brick faced with cement, may be built at a cost of about £10. The walls would be 4 to 6 ins. thick, and the bath 3 feet deep, 20 ins. wide at the top and 12 ins. at the bottom, and 12 feet in length. The sloping walk-out commences 6 feet 6 ins. from the deep or "well" end. There is a man-hole on either side, a collecting pen at the one end and a double draining pen at the other. The bath will accommodate two lowland or three Fell sheep, or four to five lambs at a time, and 500 to 600 sheep can be handled in a short day's work. (This bath is also described and illustrated in the *Journal* referred to above.)

The Cage Bath.

A third form of dipper consists of a galvanised tank sunk in the ground with its upper edge flush with the surface. In this a cage is raised and lowered by means of a hand windlass. One sheep at a time walks into the cage, and is lowered into the bath. In due course the cage is raised and the sheep walks on to the draining floor. Under this method the sheep are scarcely handled at all, the labour is easy, and risks of all kinds are reduced to a minimum.

Further information on baths will be found in the Minutes of Evidence of the Departmental Committee referred to below.*

Dips.

In some experiments conducted by Professor Winter, at the University College of North Wales, Bangor, sixteen dips were tested, and of these five (Nos. IV., V., X., XV., XVI.) were proprietary.* The sheep were immersed in an ordinary swim-bath for a period of one minute, every sheep being carefully examined at the end of 24 hours, and again at intervals until shorn a month later. A brief summary of the principal dips employed is given below :—

I.—2½ lb. arsenious acid (ordinary arsenic), 1¾ lb. washing soda, per 100 gallons dip-bath.

II.—2½ lb. arsenious acid, ½ lb. good dry caustic soda, per 100 gallons.

III.—As No. I., with the addition of 4 lb. of flowers of sulphur.

IV.—Combination of arsenic and sulphur, dip-bath containing 5 lb. free sulphur per 100 gallons.

V.—Soluble sodium compounds of sulphur, with free sulphur.

VI.—25 lb. of sulphur and 12½ lb. of lime boiled in water until of dark red-brown colour ; strain and make up to 100 gallons.

VIII.—Carbolic acid ¾ gallon, soft soap 5 lb. per 100 gallons dip-bath.

X.—A fluid carbolic dip readily soluble in cold water.

XIII.—1 gallon of a mixture of 29 per cent. tar acid, 36 per cent. paraffin, 8 per cent. lanoline, 17½ per cent. anhydrous soft soap, and 9½ per cent. water, in 100 gallons dip-bath.

XIV.—Extract of 35 lb. finely ground tobacco and 10 lb. flowers of sulphur per 100 gallons dip-bath at 110° F.

XV.—Small proportion of tar acid in addition to tobacco and sulphur.

XVI.—A tobacco, soft soap, and sulphur dip.

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* Report, Departmental Committee on Sheep Dipping, 1904, Cd. 2258 ; Minutes of Evidence, Departmental Committee on Sheep Dipping, 1904, Cd. 2259 ; to be obtained from Wyman & Sons, Ltd., Fetter Lane, E.C. Price 3*d*. and 2*s*. 4*d*. respectively.

Effects of Dips.

Keds.—With the exception of Nos. V. and VI. all the above dips were effective in killing keds, but were less successful in their action on the puparia. The tobacco dips were nearly as active, while the sulphur and arsenic preparations required a little longer time.

As the puparia appear to hatch out about 21 days after being deposited by the female, a second dipping at the end of three weeks would doubtless have a marked effect in getting the sheep clear of keds. By that time the puparia left in the fleece after the first dipping would have hatched out, and as there is no evidence to show that keds produce puparia within three weeks after they are hatched, it would only be necessary for the second dipping to destroy the keds which had appeared since the previous dipping.

It was evident that where some of the poisonous dips were used, a second dipping after an interval of 12 days was injurious to the health of the sheep, so that where a second dipping is desired for the destruction of keds, the proper time would appear to be about three weeks after the first immersion.

Lice.—There is every reason to believe that any dip which is destructive to other parasites is effective also against lice.

Ticks.—Much misunderstanding has arisen regarding the efficacy of dips for ticks, owing to the fact that in the natural course of their life history ticks leave the host whether the latter is dipped or not. Arsenical dips appear to give the most satisfactory results.

Maggots.—Sulphur is indispensable for dips against maggots, as the smell keeps off the fly. Carbolic dips, although they may destroy maggots actually present on the sheep, are practically valueless in warding off an attack. (*See* Leaflet 126.)

General.

Carbolic dips are effective in destroying all sheep parasites, and, when skilfully prepared, leave the wool and skin in a nice condition. The strength should, however, be carefully regulated to prevent irritation of the sheep. Nos. X. and XIII. were found to be the best though X. discoloured the wool somewhat.

Spirits of tar and pitch oil are apt to discolour the wool and reduce its value.

The arsenic and sulphur dips are thoroughly effective in curing scab and destroying other parasites, but the experiments clearly show that the use of strong dips of this character is attended with some danger when treating sheep affected with scab, especially if they are in low condition or have sores on them. These dips had no bad effects on the quality of the wool. (On the subject of preparing wool for market *see* Leaflet 82.)

Tobacco and Hellèbore dips, if properly compounded, may also be regarded as quite satisfactory.

The exact composition of some dips is given above, and in Leaflet 61, but farmers will find it more satisfactory to use one of the proprietary dips now on the market. Those which have been tested by the Board, and approved for use against sheep scab, bear a label to that effect.

The dippers should be instructed to pay particular attention to the upper region of the neck, which often escapes saturation when the swim bath is used. It is advisable to swab this region with dip as the sheep swim through.

Before dipping, all dung-bound wool should be removed by clipping.

Too much care cannot be exercised in keeping the bath free from gross impurities, both by skimming floating particles off the surface, and by changing the fluid at intervals. An old and dirty dip laden with manure encourages rather than retards the attacks of insects.

Whitehall Place, London, S.W.1,
July, 1905.

Revised, July, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 146.

BOARD OF AGRICULTURE AND FISHERIES.

The Value of Records of the Milk Yield of Cows.

The practice of keeping records of the quantity and quality of the milk yielded by dairy cows has made very great progress during recent years both on the Continent and in the United States and Canada. It has also been adopted in this country by the leading breeders of pedigree cows, and to some extent by the more progressive farmers in the south of Scotland, and elsewhere.

The system is of value to the milk-seller, to the butter-maker, and to the breeder, according to the object for which the cows are kept. It enables the milk-seller to know exactly what yield his cows are giving and the quality of the milk given by each individual animal. He can thus identify cows which systematically give a low yield or produce milk of low quality, and, by disposing of them, prevent the loss due to maintaining cows that are not worth their keep. Where milk is made into butter, the importance of obtaining a high percentage of fat in the milk is obvious, while to the breeder the practice of milk-testing is perhaps even more important, as by this means he can select his best cows for breeding purposes.

Simple Records of Milk Yields.

In its simplest form a record of the milk yield of cows may be kept without difficulty, and the small amount of time and trouble involved is well repaid by the value of the information obtained. All that is required is a spring balance to which a pail can be hung. Balances provided with dials on which the weight of the pail is allowed for should be used. The milk of each cow can thus be easily recorded (in pounds or in pints, according to which figure is preferred) and should be noted on a sheet ruled for the purpose and fastened up in some convenient position. If such records are kept systematically, an accurate account of the yield of each cow will be obtained and the farmer can thus distinguish between superior and inferior cows. It is true he can do this in a general way without the help of a record, but it must be remembered that some cows give large daily yields for a comparatively short period while others give moderate daily yields over a long lactation period and in any case a difference of 100 or even 200 gallons is not so easily appreciated when spread over the whole period. A difference of

100 gallons at $6\frac{1}{2}d.$ per gallon represents $54s.$, and it is probably not too much to say that cows in the same herd frequently differ in their annual production by as much as £5 without their owner being aware of it.

If the trouble of recording the milk of each cow twice daily, viz., morning and evening, is felt to be too great, an approximately accurate result can be obtained by recording the yield morning and evening on a fixed and corresponding day every week, and multiplying by 7. Experiments made in Lancashire and in the United States have shown that the error is not likely to be more than 3 per cent.

Value of Milk Records to the Dairy Farmer.

Apart from the benefits of the practice to the milk-seller and to the butter-maker, the keeping of milk records, in addition to enabling the dairy farmer to distinguish between superior and inferior cows, has many other advantages. Among these advantages are the following :—

1. Any slight reduction in yield will be noticed and investigations as to the cause can be made at once. For instance, when a cow is unwell her milk yield generally diminishes; milk records therefore may often be the means of detecting an ailing cow.

2. Feeding may be carried out more economically. Since the market price and milk-producing values of foods are not necessarily directly proportionate, it is quite possible to feed a cow expensively and not produce any better results than could be obtained from cheaper foods.

3. Where milk records are kept the influence of change of food, and the effect of different climatic conditions can be noted.

4. There is increased interest on the part of both farmer and stockman in their labours. The faculty of observation is developed, cause and effect in milk production are studied side by side, and a stimulus is given to the further study of data bearing on the work. Records have therefore a distinct educational value.

5. Milk records supply data which allow of breeding, selection and feeding of cows being conducted in an intelligent manner and thus materially assist in placing dairy farming on a sound business footing.

6. Milking qualities are largely hereditary, and the progeny of a heavy milking cow are likely to inherit the characteristics of their dam. It is therefore of the first importance that the dairy farmer should have a record of the performances of his cows, and should select the heavy milkers to breed from for his own herd. Dairy qualities are also transmitted through the bull used, and it is equally important to be able to show that he is descended from a heavy milking strain.

The possession of a satisfactory milk record becomes in this way a very valuable asset, not only as a guide to breeding, but also for sale purposes. In Denmark the prices of dairy cows are in many instances regulated by their milking records. It is in the compilation of these records that the Danish Milk Control Associations have proved of great service, and as many of them have now been in operation for upwards of fifteen years, a reliable and authentic life-history is available for several generations of the cows belonging to the herds tested. The owner of the herd can produce for the information of a purchaser a complete record, not only of the production of any particular cow, but of its dam as well, and also evidence of the milking qualities which were likely to be transmitted through its sire. He is in possession, in short, of a "pedigree of performance" in regard to his particular strain of milking cows.*

Testing Milk for Butter-fat.

Though a careful record of the milk yield is, in itself, of very great value, it is advisable that the milk-seller should also know the percentage of butter-fat in the milk of his cows. In the majority of cases the milk given by the cows of this country exceeds in butter-fat and other milk solids the percentages specified in the Sale of Milk Regulations, 1901, but it may happen that certain cows in a herd may give milk which does not contain those percentages (3 per cent. of butter-fat and 8·5 per cent. of other milk solids). This is particularly liable to be the case where the milking is done at unequal intervals. The seller of milk containing less than the percentages specified runs a risk of being charged under the Sale of Food and Drugs Acts and the Sale of Milk Regulations with selling adulterated milk. It is therefore of great importance to him that he should ascertain by testing at regular intervals whether the mixed milk of his cows is being maintained at a satisfactory level of quality. The morning and evening milking should be tested separately for this purpose. In the event of this mixed sample falling dangerously near the percentages in question a sample of the morning and evening milk of each cow should be taken in order to identify the cows which are giving milk of low quality. Experiments have shown that if a cow is well nourished, no alteration or improvement in feeding will permanently alter the quality of her milk, but in some cases circumstances admit of other alterations in the

* An account of the effect of these Societies on Cattle Breeding in Denmark appeared in the *Journal of the Board of Agriculture*, Vol. xvi., March, 1910, p. 1002.

management of a herd or changes in the conduct of a business which will enable the dairy farmer to avoid the risk referred to above.

Where milk is used for butter-making it is essential that the dairyman should ensure that all his cows are yielding milk with a high percentage of butter-fat, otherwise (unless a very high price is obtained for the butter) the value obtained for the milk is very low. For instance, 3·6 per cent. of fat in the milk is equal to a butter ratio of 1 : 25—that is, every 25 lb. of milk will produce 1 lb. of butter; so that if the butter only fetches 1*s*. a pound, it represents less than 5*d*. a gallon for the milk.

The testing of milk for butter-fat can be done on the farm by means of the Gerber or Babcock testing apparatus. The use of this apparatus requires a certain amount of skill and care, but an intelligent dairyman will quickly learn to use it properly. Samples of milk can also be sent to most of the Agricultural Colleges for the purpose of determining the percentage of butter-fat, the fee charged being usually 6*d*. per sample. In addition Milk Recording Societies, of which a description is given below, are now being formed in many districts and in such cases the testing for butter-fat may be arranged for by the Recorder attached to the Society.

Instructions for taking Samples.

In taking samples of milk for the purpose of determining the percentage of butter-fat the following procedure should be observed. Samples should be taken in all cases immediately after milking. It is of the utmost importance that the milk which is about to be sampled should be thoroughly mixed, and should not be allowed to stand after mixing before the quantity of the sample is taken.

The mixing may be carried out by agitation with a plunger. The plunger should consist of a circular metal plate, 6 to 7 inches in diameter, perforated with a number of half-inch holes, and attached to a handle sufficiently long to reach the bottom of the milk to be mixed. In mixing the milk the plunger should be pushed to the bottom of the vessel and brought to the top of the milk as rapidly as possible not less than ten times. The position of the plunger should also be moved from place to place to ensure that the whole of the milk at the bottom of the vessel is thoroughly roused and mixed with the upper layers.

If more convenient the milk in a particular vessel may be mixed before sampling by pouring the entire contents of the vessel into an empty vessel and back again three times.

A. *Testing the milk of one cow.*—All the milk, including the "strippings" drawn from the cow at a milking should be brought together in one vessel and thoroughly mixed. A portion of the milk should then be at once removed with a

jug or a dipper and transferred to a clean dry bottle capable of holding at least a quarter of a pint. The bottle should be immediately corked and sealed.

If it is desired to take the sample in duplicate, the whole of the milk required to fill the two bottles should be taken from the mixed milk at one filling of the jug or dipper.

B. *Testing the milk of a herd:—*

(a.) *Where the total quantity of milk from the herd can be placed in one churn, or vessel, or mixing tank.*

All the milk should be placed in one churn or receptacle, and mixed thoroughly, as described above. A sample should then be taken as under A.

(b.) *Where the total quantity of milk from the herd fills more than one churn, and there is no single vessel available in which it may be mixed.*

The milk should be distributed as equally as possible among a number of churns or similar vessels. This may be conveniently carried out by pouring the milk as received from the milking of the herd into as many churns as may be required. The churns should not be filled, but the *same quantity* should be placed in each. If there remains a quantity of milk less than sufficient to fill a churn to the same content as the others, this quantity should be divided as equally as possible among the churns already used. When this has been done the contents of each churn should be thoroughly mixed, and one gallon taken from each. These portions should be placed in another churn or vessel, thoroughly mixed, and a sample taken as under A.

An important point in connection with these tests for butter-fat is the frequency with which they are required to be made in order to give an accurate indication of the average richness of the milk. Cows vary so much in the amount and quality of their milk from one milking to another that exact results cannot be obtained by testing the milk from one milking at distant intervals.

Formation of Milk Recording Societies.

Under the Scheme for the Improvement of Live Stock the Board of Agriculture and Fisheries may make grants to Milk Recording Societies, if their rules conform substantially to the model rules issued by the Board.

These model rules and the regulations as to the award of grants by the Board are as follows:—

Model Rules for a Milk Recording Society which is formed for the purposes of the Board's Scheme.

1. The Society shall be called the   Society, and shall consist of the original members who determine to form the Society, and of members elected under these rules.

A person on becoming a member shall sign a copy of these Rules as evidence of his agreement with the Society to be bound by these Rules or any amendment thereof duly made. The copy shall be retained by the Society.

Until the first ordinary general meeting the Committee of Management shall consist of the original members.

2. The object of the Society shall be to improve the standard of Dairy Cattle and the methods of feeding them by encouraging the keeping of reliable records by members of the Society of (*a*) the yield of milk, and also (*b*) the quality of milk, or (*c*) the food consumed by the cows, or both of these matters.

3. Members other than original members shall be elected at any meeting by the Committee of Management.

The election of a member during a Society's year of operations shall take effect as from the commencement of the next year of operations, unless otherwise agreed between the member and the Society.

4. The Society may accept subscriptions of not less than 2*s.* 6*d.* from persons who do not desire to become members. Such persons are in these Rules referred to as honorary members.

5. The members shall, at the commencement of each year of the Society's operations, pay to the Society such annual subscription (if any) as may be fixed by the Society, and shall, half-yearly, pay to the Society on demand such further sums as the Society may determine to be necessary to defray the expenses of the Society for the ensuing half-year and any deficit from the preceding half-year, and such estimated expenses shall be apportioned by the Committee of Management among the members in proportion to the number of dairy cows owned by them at the date of apportionment.

6. Resignation of membership shall take effect only at the end of a year of the Society's operations and if the member concerned has paid all moneys due from him to the Society and has given in writing to the Secretary of the Society at least three months' notice of his resignation.

7. An annual general meeting of members shall be held at the commencement of each year of the Society's operations to receive a report and statement of accounts for the past year, to elect the necessary officers and a Committee of Management (hereinafter called "the Committee"), consisting of not less than three ordinary members, together with such honorary members as they may wish to co-opt, and to transact any general business of the Society. The Secretary shall give each member ten days' notice of the annual general meeting of the Society, the date of which shall be fixed by the Committee, and shall also notify him of any special business to be transacted.

8. The Secretary shall at any time call a special general meeting of members by direction of the Chairman or the Committee. The Secretary shall give each member five days' notice of any special general meeting of the Society, and shall also notify him of any special business to be transacted.

9. Three members of the Society at any meeting shall form a quorum. In the event of equality of votes the Chairman of any meeting shall have a second or casting vote.

10. The Committee shall be empowered and authorised to transact all business in connection with the Society. They shall fix the date of the commencement of the Society's year of operations, *i.e.*, the period during which the milk records are to be taken.

11. The Committee shall be authorised to proceed through the Secretary of the Society against any person for any subscription or other sum of money due from him to the Society.

12. The Committee shall submit to each member, at least ten days prior to the annual general meeting, an annual report and a duly audited statement of accounts setting forth all expenses incidental to the working of the Society, the income derived from members' subscriptions, levies, grants, and also, if any, donations, and honorary members' subscriptions.

13. *No dividend or bonus shall be paid to members*, and, in the event of the Society ceasing operations, any surplus of assets over liabilities shall be divided between the existing members of the Society in such manner as a general meeting of the Society shall determine.

14. The Committee shall bring before a general meeting the name of any member whose payments are in default or whose conduct or action appears to them to be in contravention of these Rules or detrimental to the interests of the Society; and, failing a satisfactory explanation of such default, conduct or action, the member in question shall, by a majority vote of members present, be expelled from the Society and shall forfeit all rights to which he may, as a member, be entitled.

15. Each member shall periodically weigh the milk of each cow in milk in his possession on such days as the Committee shall direct, and furnish the Committee by such date as may be required with a signed annual record of such weighings. He shall also afford facilities for the weighing of the milk and examination of the records of milk yield by any officer appointed for that purpose by the Society, or by the Live Stock Officer for the Province, and for the marking of his cows by the Society's officers for purposes of identification.

16. All moneys belonging to the Society shall, immediately on receipt by the Secretary or Treasurer, be placed to the credit of the Society's banking account. All payments on behalf of the Society shall be made by the person or persons authorised by the Society.

17. It shall be the duty of the Secretary to summon (by notice to each member) and to attend all general meetings and committee meetings, and to report in a minute book the names of the members present and the proceedings thereat; to keep the accounts of the Society; to keep a register of members and of the days on which each member is required to weigh the milk of his cows and of the hours at which the milkings commence; to furnish the necessary information and forms to any officer appointed to examine milk records, and generally, to carry out the instructions of the Committee.

The remuneration of the Secretary shall be fixed at a general meeting.

18. Any proposed revocation or alteration of, or addition to, the Rules may be adopted by the Society at a general meeting if the Secretary had given each member particulars of such proposals at least ten days prior to the date of the meeting.

The Secretary shall notify the Board of Agriculture and Fisheries of any revocation or alteration of, or addition to, the Rules.

19. If any matter or question not provided for in the foregoing Rules arises, the decision of the Committee shall be final.

Regulations as to the Award of Grants to Milk Recording Societies.

The Board are prepared to make grants to Societies in accordance with the following regulations:—

1. Applications for grants shall be made by a Society to the Live Stock Officer of the Province, who will report thereon to the County Live Stock Committee. No application will be entertained unless the ordinary members of the Society are not less than ten in number and own between them at least one hundred cows in milk.

2. The Rules enable a Society to raise part of their income by annual subscription, payable by each ordinary member of such amount as the Society determine. The Board will not award a grant to a Society which imposes an annual subscription exceeding £2. The rest of the necessary income will be raised by levies based on the number of cows of the several members.

3. Grants will be made to Societies only if their Rules conform substantially to those issued by the Board.

Registration of Societies (under the Industrial and Provident Societies Act or the Friendly Societies Act) is not essential

4. Members must agree to keep milk records of each cow* in their herds. The milk of two consecutive milkings of each cow must be weighed separately, evening and morning, not less frequently than once a week during the whole period of lactation, and on the same days in each week. The days for each member will be selected by the Committee. If records are not taken daily, Saturday evenings, Sundays, and Monday mornings must not be selected.

5. Recorders whose main duties will be to check at proper intervals the Milk Records, shall be appointed by the societies subject to the appointments being approved through the Live Stock Officer by the County Live Stock Committees. The Recorders shall carry out their duties in accordance with the Board's instructions.

The Recorder shall not be a member of the Society nor have any financial interest in the business of any member of the Society.

6. Societies shall pay Recorders such salaries as they may think fit.

7. Members must allow Recorders or the Live Stock Officer to be present at any reasonable time to see their cows milked, and the milk weighed, and must also allow the Recorders or Live Stock Officer to examine all or any of their books or papers relating to the keeping of Milk Records.

8. The Society must arrange that a Recorder, without notifying the owner, will visit each herd not less than once in every six weeks.

9. The milk shall be weighed on a spring balance with a dial of a description approved by the Live Stock Officer.

10. Records shall be kept by all members on forms supplied by the Board for the purpose, giving the particulars required by the Board.

11. A Society shall determine the date on which its year of operations, *i.e.*, period during which the milk records are to be taken, shall commence. The milk yield of each cow belonging to a member of a Society is to be recorded by the member during a complete year, or during such part of the year as the cow is in the member's possession. The record of such yield shall contain the date of the last calving, the date when the next calving is due, and such other particulars as may be required by the Board. An estimated yield will not be allowed for the time during which a calf is sucking a cow. The milk yielded during the first four days after calving or before the date when the calf is weaned is not to be included in the record.

12. Cows shall be marked at the expense of the Society with an identifying mark and number in the ear by the Recorder or other person appointed by the Society for the purpose.

13. A Society will not be eligible for a grant unless the ordinary members are not less than ten in number and own between them at least 100 cows in milk.

14. The maximum annual grant payable by the Board to a Society is £50, unless the herds of the members of the Society exceed twenty-five, in which case the Society shall be eligible for a proportionately increased grant.

For the purposes of this rule cows of one owner which are milked at different places which do not enable the Recorder to check their milk yields at one visit shall be treated as separate herds.

A Society may employ, as Recorders, whole time or part time officers, but unless there are at least twenty herds to be examined the Board will not recognise the employment of a whole time officer as reasonable. Subject to these provisions the grant will be equivalent to one-half of the expenses reasonably incurred by the Society.

15. Societies must furnish the Board with copies of the annual milk yields of every cow belonging to its members. Forms for this purpose will be provided by the Board free of cost and all the particulars asked for on these forms must be given.

16. The Board reserve the right to publish any milk record, or any information relating thereto, except that the name of a Society, or the

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* In these rules and regulations the word "cow" includes heifer in milk.

name and address of the owner of a cow, will not be published unless the Board first obtain the written consent of the Society or owner, as the case may be.

17. Societies applying for a grant must submit their rules to the Board for approval.

18. As soon as the Recorder or Recorders have visited and checked for the first time the milk records of all cows under their supervision which are in milk and have marked all these cows with an identifying number, the Secretary of the Society may apply to the Board for a grant of 1*s.* per cow for all these cows, on account of the grant payable to the Society.

19. At the end of the milk record year, the Board will pay any part of the grant that may not have been paid to the Society for any additional cows whose records are checked by the Recorder, and for any other expenditure incurred in accordance with the Regulations.

20. Certificates of the annual milk yield of any individual cow or cows in a herd will be issued by the Board on the application of the owner of such cow or cows through the Secretary of the Society in the following form, or to the like effect.

BOARD OF AGRICULTURE AND FISHERIES.

Certificate of Milk Record.

Identifying Mark and No. of Cow.	Description of Cow, name (if any) and breed.	Age of Cow.	Number of calves the Cow has produced to the close of the year mentioned below.	Date when Cow last calved previous to close of the year mentioned below.	Date when the Cow is again due to calve.	Number of days the Cow was in milk during the year mentioned below.

Owner of above cow . Address :

The Board of Agriculture and Fisheries hereby certify that from the records kept by the owner of the above cow under the supervision of the Society, and, subject to inspection by an approved Recorder, it appears that the **yield of milk* given by the above cow during the *year* commencing , 19 , and ending , 19 , was lbs.

The records were taken . (Insert daily or weekly.)

In witness whereof the Board of Agriculture and Fisheries have hereunto set their Official Seal this day of , 191 .

(L.S.)

Secretary.

* This yield does not include the yield during the four days next after calving nor the yield prior to the when the calf was weaned.

Duties of Recorders.

1. A Recorder shall, at least once in every six weeks, without notifying the owner, visit each herd under his supervision at milking time both at evening and the following morning.

2. He shall see each cow milked and the milk weighed, and shall state on the Form with which he will be provided the number of each cow, her name (if any), her description, the date of the last calving, the weight of milk given at each milking, the weight of milk given by the cow as recorded by her owner when he last weighed her milk, and at previous weighings, if necessary, and any other information required by the Board.

3. He shall, if directed by the Society, take a sample as prescribed in Leaflet 146, of the mixed milk from all the cows in the herd at his evening and morning visit, and shall, as directed, forward such samples to be tested for Butter Fat. The cost of carriage and testing is to be paid by the Society.

4. He shall, if requested by the owner of the herd, take a sample of the mixed milk (if not taken by direction of the Society) or samples of the milk from any individual cows for the purpose of having them tested for Butter Fat, as prescribed in Leaflet 146. In such cases the cost of carriage and testing is to be paid by the owner.

5. He shall, if requested by the owner, take particulars of the feeding rations of the cows, and shall forward them to the Live Stock Officer of his Province for advice thereon, as opportunity offers.

6. If a Recorder considers that through ignorance, carelessness, fraudulent intention or any other reason the milk records are not being kept by the cow-owner or anyone in his employ in a proper manner, he shall draw the attention of the cow-owner to the fact, and shall also draw up a report in writing and send it to the Live Stock Officer who shall, if necessary, bring the matter to the notice of the Board.

7. At the end of the milk recording year, the Recorder shall check the additions and calculations which it is necessary to make to arrive at the milk yield per annum of each cow which he has supervised, and shall countersign the return furnished under Rule 15 to the Secretary of the Society.

Whitehall Place, London, S.W.1,

May, 1905.

Revised, June, 1914.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Fences and Hedges.

One of the difficulties with which landed proprietors, farmers, and others interested in estates have to contend is the formation and maintenance of hedges and fences. The difficulty is often increased by neighbouring owners of boundary fences paying little or no attention to their maintenance. A little timely assistance on the part of the landlord and the tenant might have preserved many good thorn fences in those parts of the country which are now practically denuded of them. The expenditure and trouble necessary to put in a thorn hedge, to erect guard fences, and to keep them in proper condition for twelve or fifteen years (the time it takes to rear a thorn hedge strong enough to turn heavy stock), should be an inducement to all concerned to take care of those hedges which are in fairly good growing condition. Fences erected as boundaries between farms should be well kept up, more especially those marking the boundaries of estates.

Thorn Hedges.

There are several causes that tend to produce ill-kept thorn hedges, and they may be briefly stated as follows:—(1) Throwing of several grass fields into one and neglect of the old division fences. (2) Bad yearly switching or dressing of hedges, with little or no attention as to how they are cut or the proper shape they ought to assume. (3) Want of proper protection to fences newly cut and layered. These ought to be protected for at least three years, and be kept free from weeds. (4) Non-fulfilment of agreement between landlord and tenant as to the up-keep of fences. (5) Changing of farm hands, and consequent lack of consecutive management or treatment. (6) Hares and rabbits. These, where they are numerous, do a considerable amount of harm to quick fences, by barking the stems.

The whitethorn or hawthorn (*Cratægus Oxycantha*) has been proved to be the most useful plant for forming hedges as barriers against stock. Its adaptability to situation and soil are important factors in its favour; it is long-lived and stands cutting even to an old age and is therefore easily kept within bounds.

The time it takes to rear a thorn hedge depends on (*a*) the quality and preparation of the soil; (*b*) the situation; (*c*) the care that is exercised in keeping it clean; (*d*) protection

from stock ; and (e) the method adopted in training. Before laying out hedges there are many things which ought to be considered. If the proposed fence is intended to divide fields, or to serve as a boundary between estates, it is nearly always advisable that it should be straight. There are, however, certain lines of division which cannot be altered, such as streams serving as boundaries. In laying out fences between estates a give-and-take line may often be advantageously adopted by mutual consent of the landlords concerned.

Soil, Draining and Trenching.—The soil most suitable for the thorn is a strong loam. The land must be thoroughly drained, and for this purpose the open ditch is in most general use. This form of drain, however, is frequently undesirable on arable land as it wastes space and harbours rabbits and the labour required to keep it clean is also considerable. The better method is to run a pipe drain 5 or 6 ft. from the fence on both sides. Drains already in the ground may sometimes be utilised for the purpose. The conformation of the ground does not always admit of the drains being run parallel to the hedge, but the main point is to carry out the work in the way that will best keep the hedge dry. In running through hollows where it is occasionally difficult to drain thoroughly, the soil may be raised and a drain-pipe put through the fence to allow the water to pass from one side to the other. Hedges should never, if it can possibly be avoided, be planted on these raised beds.

Although banks are often undoubtedly of use in making a fence, the system of planting hedges on banks possesses certain grave disadvantages, especially on arable land. The banks occupy a considerable area of ground, being frequently 5 or 6 ft. across. In the course of time they become full of the roots of trees, brambles, &c., so that it is quite impossible to keep them free from weeds. These weeds spread their seeds throughout the field and undoubtedly greatly add to the difficulty of keeping the land clean. Even if the weeds are cut down annually with a hook large numbers of their seeds are distributed throughout the fields.

The ground having been drained, trenching operations can be proceeded with, the bed being kept on the level. Trenching ought to be done in the autumn previous to planting. In making the trench or bed it should be 3 ft. or 4 ft. wide, and 18 in. or 20 in. deep. If the soil is good to that depth, the bottom soil may be brought to the top, the top soil, if grass land is being trenched, being laid in the bottom of the bed. The soil should be thrown up roughly in the middle, to expose it as much as possible to the influence of frost, care being taken to remove all weeds, especially deep-rooted ones, such as docks, thistles, &c., which if left in will be difficult to eradicate without considerable damage to the thorns.

Planting.—Good, healthy, strong plants, which have been previously twice transplanted to ensure fibrous roots should be used. Before planting takes place the stems should in most cases be cut off 2 to 3 in. above the soil line—that is, 2 to 3 in. above the depth at which they stood in the nursery row. Long or damaged roots should be neatly cut back. In fencing pastures there are some advantages in planting thorns in double rows, the rows being placed 8 in. or 9 in. apart, and plants in the rows the same distance, each plant in a row dividing the space between the two opposite in the other row.

The thorn thus planted is given more room, and the result is the production of strong lateral growth. If a double-rowed thorn fence should in after years, through neglect, assume a spreading habit, one of the rows may be cut off at the base some years in advance of the other to encourage fresh growth; when strong enough to act as a fence, the other side may be treated in the same way. Care should be taken not to allow a double-rowed hedge to become foul, for there is great difficulty in cleaning out the weeds: and if there is reason to fear that the hedge may be neglected the thorns are better planted in a single row. In planting hedges on arable land a single row of plants 6 in. to 8 in. apart would be most satisfactory. Having consolidated the soil somewhat in the centre of the bed by treading, the operation of putting in the plants can be begun. It takes two men to put in the plants properly. After the first spadeful of soil is laid on the roots, the plant should be drawn lightly up and down so as to cause the soil to run into the interstices formed by the rootlets. The placing of the thorn being completed, more soil is laid on the roots and carefully firmed round the stems, finishing by drawing the soil to the plants, leaving them just pointing the surface.

There is another plan which has been adopted with considerable success. The stems are left a little longer than is advocated above, and the soil is made to cover the whole of the plant, which is left in this condition until it shows signs of vitality in the spring. The soil is then taken from the plants to the depth of 3 or 4 in., forming a V, with the plant in the middle. The shoots, it is said, come away stronger, and are more numerous than when the thorns are left standing above ground at the time of planting.

Cost.—The cost of trenching, purchasing plants, and planting, runs from 4*d.* to 6*d.* a yard, the cost being principally affected by the nature of the ground. Very often this is not the only expense to be met in putting in a quick fence. Protection rails may have to be erected on one or both sides, and this adds considerably to the initial outlay and up-keep. A three-barred fence, using sawn morticed

oak posts and larch rails, can be put up for about 1*s.* 2*d.* per yard, while a four-barred fence will cost 1*s.* 6*d.* per yard.

Protection is absolutely necessary in the case of pastures, but with arable land this expense is often saved. Temporary protection from the sheep that consume the crops of tillage land must be given, or otherwise the quicks will be damaged, not only by the teeth of the sheep but also by the wool that is left on the lateral growth. One of the greatest drawbacks to the forming of thorn hedges is the fencing required for protection, and the outlay is certainly heavy when it is found necessary to protect the fence on both sides, and occasionally wire-netting must be used to ensure success if rabbits abound. Assuming, then, that protection from stock and rabbits is necessary, the expense works out as follows :—Trenching, purchasing and planting thorn, 5*d.* per yard ; two guard fences, including cost of erection, 2*s.* 6*d.* per yard ; wire-netting, 6*d.* per yard, making a total expense of 3*s.* 5*d.* per yard. But it is seldom found necessary to go to this expense. The prices quoted are for first-rate material, which ought to last until the hedge is in a condition to act as a fence, and then be of further use for repairs.

Trimming.—Except for cutting back the thorn at the time of planting, a thorn hedge should not be trimmed or dressed until four or five years after planting. The stems of the plants then thicken more than when they are trimmed from the first, and when cut back to, say, 2 ft. from the ground they present a strong appearance. A great many of the thorns will have developed two, three, or four shoots, some of which can be dispensed with, and should be cut near the bottom to encourage further growth at that place.

After first commencing to trim into shape a hedge which is not growing well, it is an advantage to trim every alternate year instead of yearly ; this treatment has a tendency to strengthen it.

The way in which hedges are trimmed determines both their shape and stability. In order to ensure success dressing should be done with an upward stroke, making the hedge wedge-shaped, while there should be no haste to raise the hedge to its full height. Hedges which have been raised too rapidly are often unable to act as a fence owing to the weakness and looseness of growth. Those which are trimmed regularly for many years sometimes get, in spite of attention, so unshapely and unnecessarily large, that it is desirable to rib in, or cut back the lateral growth to the main stem to bring them back to their former shape, and it is equally necessary to encourage growth by cutting back to the base all weakly or suppressed stems. Adjoining pastures, this operation is rather risky unless the fence is protected for a time.

Hedges which are well cared for and regularly trimmed may be trimmed in February if in exposed situations, or at any time from August to February if sheltered. Neglected hedges, however, which require hard pruning, should be taken in hand in autumn in ordinary situations, or in early spring in cold, exposed positions. The whitethorn is very hardy, but might suffer if severe frost followed soon after pruning.

Weeding.—Too much cannot be said in favour of keeping hedges clean, and it is often necessary to clean twice or three times during the year where weeds are troublesome. If hedges are allowed to become very foul there is always a danger of the plants getting damaged in the attempt to root out the weeds, and there is also a great loss of nutriment, to say nothing of the soil thrown off with the weeds. Weeds also harbour insect pests which may attack the hedge. The first cleaning should take place in spring, before any seeding occurs. On land which is very weedy and of a tenacious character, it is often found that, owing to the great amount of cleaning necessary, the soil on the roots of the plants becomes deficient. This is rarely experienced before the fence is of sufficient size to do without hand weeding, and at this period it is well to add fresh soil, and to keep clean by cutting down the weeds with a sickle twice annually, or oftener if required. When a hedge is laid beside a ditch, the latter should be cleaned out and the mud plastered round the roots of the hedge, in order to protect them, and to keep the soil from gradually falling away.

Maintenance of Hedges.—The layering of old thorn hedges must be carefully done, and some protection is necessary until the new growth is strong enough to resist cattle, and until the "layers" are firmly fixed in their new position.

In the case of a moderate-sized hedge, the layering may be performed at any time from November to April. Where a big old hedge which has been neglected in the past has to be dealt with, the work should be performed in April, just when the sap is beginning to rise. In the spring time it is found that the layers of an old hedge are less brittle and less liable to break off than in the dead season.

Stakes.—About every 2 or 3 ft. in the hedge an upright stake is necessary, in order to keep the "layers" in their proper position. These stakes may be "dead" or "live." "Dead" stakes, about five feet in length, are cut out of the hedge as opportunity arises. They are driven into the ground until firm, and are then cut until at the general level of the finished hedge. The thickness of the stakes is not a matter of great importance, provided they are strong enough to keep the layers in their proper position.

If live stakes are used, they should be reduced to the desired height and then cut about half-way through at the bottom. The object of this is to encourage young shoots from below the cut and not from the top of the stake. An objection sometimes made to live stakes is that careless or inefficient hedgers frequently neglect to cut their stakes partly through at the bottom, so that many good farmers insist that only dead stakes shall be used. All brambles and undergrowth should be cut away before commencing to lay the hedge.

Layers.—The tallest thorns in the hedge should be used as layers. They should be partly cut through, leaving a tongue, with bark, attached to the parent stump, the thorn being bent over so that it stretches along, and is worked in and out amongst the live stakes. The parent stump should be trimmed clean, so that no ragged portions project; if this is not done rain will enter the stump and gradually rot it. If dead stakes are used it will frequently be convenient to insert them after some of the layers are down.

The layers should be so arranged that their thorny part projects on that side of the hedge on which there is most danger of damage by cattle, and on the opposite side to that on which the man is working Some hedgers recommend that the layers be bent over in such a way as to leave the stumps free. If this is done the growth from the latter does not become entangled with the layers, so that in the course of years, when it is desired to lay the hedge again, difficulty is not experienced in dragging out the old layers. The objection to it, however, is that should land on both sides of the hedge be open to grazing animals, the young shoots from the stumps will be eaten off, so that it will be necessary to erect a dead fence of thorns to protect the shoots.

If the layers are arranged directly over the stumps, the shoots from the latter will find their way amongst the layers, and in the course of years form an almost impenetrable fence—a mixture of layers and upright shoots.

At the end of a hedge, near gateways and trees, and where the fence is very thin, it will frequently be necessary to place some of the layers in an opposite direction to that in which the hedge is being laid. In fact, a skilled man will use every available piece of live thorn in a thin fence, working it into the laid hedge in various directions.

Layering, while suitable for most parts of England south of the Tees, is not much practised in the north or in Scotland. In some experiments recently made in connection with the renewing of old hedges in Fifeshire, it was found that shoots half cut through near the ground are apt to die off in the cold northern climate, but that the following method of renewing irregular and overgrown hedges is successful.

If the fence is ultimately required to be 4 ft. high, the hedge should be cut clean across to a height of under 3 ft., any supple shoots being tied down to cover as many gaps as possible. The tying should be done with No. 18 galvanised wire, but care should be taken to tie down the shoots loosely, to allow for growth. The hedge being only cut to a little under 3 ft., it is not necessary to keep the roots of the hedge clean otherwise than by cutting the long weeds that might grow up through the naked hedge. In this state the hedge should be left for three years, when it should be switched up, leaving the top shoots. These shoots should be thinned to the required distance, and laid down and tied horizontally across the top of the hedge to cover all blanks. If this single process did not suffice to make a close fence, the hedge could be allowed to grow for the necessary time, the operation being then repeated. The hedge after laying should be perfectly close, and could be kept trimmed every year or every second year according to taste.

The fences dealt with in the experiments were upon arable land under rotation and grazed for two or three years. As the lands are in crop for five or six years, the operation described may be commenced when the grass is broken up, so that by the time the land comes into pasture again the operation should be finished, leaving a suitable fence for stock. It is not, therefore, necessary to protect the hedge against stock during the process of renewal.

Binding.—After the fence has been laid along its entire length, it is "bound." Brambles, briars, &c., are cut off and twisted along the top of the hedge from stake to stake to keep the layers neat, and in their proper position. These will become rotten in a few years, but then they are no longer needed. Occasionally live material is used for binding. It cannot usually be worked up so neatly, however, as dead stuff. It may also be noted that live bindings increase the risk of accidents in the hunting field.

Subsequent Treatment of Hedge.—After a fence has been laid, it should be trimmed annually with the slasher until such time as it becomes thin at the bottom, after which it may be allowed to grow up to a height of, say, 12 to 15 feet, when it should be again laid.

In pastures, and where it is desired to maintain a good thick fence for shelter, it may occasionally be better not to slash the edge, but simply to allow it to grow up until it again requires laying. If either of these methods is adopted, a thoroughly good fence should be maintained.

Neglected Hedges.—It often happens that hedges have been neglected for long periods, and much of the thorn may have died. Where this is the case it may be necessary to replant the thinnest portions.

A really skilful hedger will, however, utilise existing material so that a most unpromising fence may often be restored to a respectable condition in a few years.

Hedging Tools.—In order that hedgers may perform first-class work it is absolutely essential that they should be provided with proper tools.

The principal tools necessary are a bill-hook and a good axe. A pair of strong leather mittens or gloves should also be available.

The bill-hook used should have two cutting edges, the one straight at the back of the hook, the other gradually curved. The straight edge is used for cutting all the lighter wood, the axe being reserved for thorns exceeding four inches in diameter. In some parts of the country a type of bill-hook is used which has only one cutting edge, with a very sharply curved hook at the end. This is a most inconvenient tool, and should be rejected in favour of the type described above.

All tools should be kept extremely sharp, or good clean work cannot be performed.

Other Hedge Plants.

The Beech makes a splendid hedge for screening and sheltering, and grows best on a gravelly soil holding plenty of lime. It stands exposure well. Since it is a shade-bearing tree, it can be grown where thorn or any other light-demanding plant would not be a success, while it may be trained to a good height without losing its closeness of growth. The annual trimming induces it to retain part of its leaves during winter, thereby enhancing its value as a shelter. The cost of putting in a beech hedge is from 4*d.* to 6*d.* per yard. Beech ought not to be cut over at the time of planting.

Hornbeam also may be used. It is a slow grower but has much greater reproductive power than beech and will grow in badly drained and wet soils where beech and thorn will die.

The Holly is a good hedge plant, and has the advantage of being evergreen, but it grows slowly, and is specially liable to be eaten by rabbits. The soil in which this plant grows best is a sandy loam. It should be planted in May or September, using twice transplanted roots; these should have as much soil as possible adhering to them, and be lifted and planted the same day. Should the roots become dry, watering at the time of planting is necessary. A bed should be prepared somewhat similar to the one advocated for the thorn, and if the soil is thin it would be an advantage to give a mulching of manure. Little attention is required for some years as regards

training to any particular shape, beyond what is necessary to check the lateral and top growth of any plants which have for some reason grown faster than the rest, so as to bring the hedge to a uniform height and thickness. Annual trimming with shears, which ought to be done in summer, need not be commenced until the hedge is nearly high enough to act as a fence. The holly being a shade-bearing tree, can be trained into almost any shape, as the bottom growth is not much interfered with by the spreading of the top. It makes a good screen for gardens, orchards, &c., and can be grown to a great height with an unbroken face from top to bottom. The cost is about 10*d.* to 1*s.* per yard when 12-in. plants are used.

Evergreen Privet makes a nice garden fence, and is easily reared and tended. It may be put in as cuttings, or the cuttings may be allowed to stand two years in a nursery, and then be planted out. In a very short time it will grow into a nice neat fence if cut in closely.

Wire Fencing.

This class of fence is much used in Scotland, and is now owing to its cheapness and durability, becoming more common in southern districts. Often, however, wire fences are erected in positions where they are very liable to breakage. The most suitable places are plantations, road-sides, clumps, and pleasure grounds. If a wire fence has to be erected between pastures—a position somewhat unsuitable for such a fence—a rail should be run along the top in place of wire. This gives stock a better chance of seeing the fence when galloping. The cost of erecting a good wire fence, composed of oak or larch posts, standing 6 ft. apart and using galvanised wire, is 10*d.* to 1*s.* per yard.

Stone Walls.

A stone wall forms a good fence and is durable. The cost varies considerably, depending on the distance the stone has to be carted and the ease with which it is obtained. To build a wall 4 ft. 6 in. high, with two rows of throughs, tapering from 2 ft. to 10 in., and limed top and throughs, costs about 3*s.* 6*d.* to 4*s.* per yard when carting and material have to be paid for. If the cost of carting and material is not considered, then the price would be about 2*s.* per yard.

Creosoted Fencing.

The cost of erecting a fence of creosoted redwood to turn heavy stock is as follows :—Two top rails, 12 ft. by 4 in. by 1½ in., at 10*d.* each ; two bottom rails, 12 ft. by 3½ in. by 1¼ in., at 8*d.* each ; two posts, 6 ft. by 6 in. by 3 in., at 9½*d.*

each; erection at 2½*d*. per yard; making a total of about 1*s*. 4*d*. per yard. It is advisable to obtain, if possible, material free from knots, as the rails are easily broken at the places where the knots are, besides which many of the knotty rails are either cut out of young trees or from the tops of old ones and are therefore immature, decay sooner, and are lighter. In erecting a fence of the above material, the rails having the least knots should be nailed on the upper part of the fence.

Seasoning of Fencing Material.

The object in seasoning is to get rid of all the moisture or sap, and to accomplish this various methods may be adopted. The only method referred to here will be that of drying in open sheds, *i.e.*, admitting a free current of air and protecting from rain. In order to check decay, no time must be lost in placing sawn timber under cover. It should be allowed to remain so protected for at least one year, and during this time should be re-stacked or turned over to facilitate drying. In the case of timber which is used for outdoor purposes, the gain from proper seasoning would amply repay any expense incurred in erecting necessary plant.

Durability being a most important quality in fencing material, a primary object must be to obtain matured timber, which is the best to use, whether seasoned or unseasoned. Mature timber contains less sap wood than immature, and there is consequently less shrinkage and less liability to attract organisms which hasten decay.

Preservative Methods.

The common methods are painting, tarring, and charring, but the work should never be done until the timber is seasoned.

The cost of painting rough outside work is prohibitive, but work, such as dressed paling, gates, &c., erected in places where people are liable to come in contact with the woodwork, is better painted than tarred. Tarring is the most common method employed in preserving outside rough woodwork. Gas tar should be kept for some time before using as it improves by keeping. Charring is very useful for preserving posts, as it forms an outer coat of charcoal which is immune to the attacks of insects and fungi, and is almost indestructible when placed in the ground. The disadvantages of charring are a loss of wood and cracking; the charred parts should be tarred over, thus plugging up the external cavities of the wood, and preventing the entrance of air and water.

Whitehall Place, London, S.W.1,
July, 1905.
Revised, August, 1913.

Leaflet No. 148.

BOARD OF AGRICULTURE AND FISHERIES.

Planting Fruit Trees and Bushes.

Time of Planting.

November is, in general, the best month of the year for planting fruit trees and bushes. The leaves have then fallen, and the soil is always moist enough, while it is less likely to be too wet than at a later period of the season. Planting may be carried on, however, all through the winter, and in the early part of the spring, before the buds have started in growth, whenever the land is in a suitable condition—that is, is free from excessive wetness and frost.

It frequently happens that apple trees retain their foliage until mid-November, and it is a bad plan to move the trees until the leaves fall. The trees do not suffer, however, if the leaves are stripped off at once when the trees are lifted.

Soil and Position.

Although soils over the Old Red Sandstone, the Greensand, or the Lias, or deep alluvial soils, are among the best for fruit, satisfactory results can be obtained on any land that will grow corn, clover, and potatoes well, or where the elm tree flourishes naturally. Stiff clays, very shallow soils of any class, and burning sand or gravel soils are, speaking generally, to be avoided, though excellent crops of fruit, notably apples and cherries, are produced on such a strong soil as the Weald. Land having a gentle slope to the south is best, and the closer the south-west is approached the more necessary is natural or artificial shelter to protect the trees against gales from that quarter; but there are many good orchards on level plains, and some with aspects which would not have been selected if a choice had been available. A site fully exposed to the south-east renders blossom and foliage liable to injury when the sun rises in a cloudless sky after a frosty night; while basin-shaped hollows, or the proximity of water, should always be avoided, owing to the greater intensity of frost in such places.

Preparations for Planting.

Preparations for planting should be made much earlier than November, as the land must be drained if water is likely to stagnate in it, and it needs to be thoroughly cultivated before the holes for trees and bushes are dug. Land in which an early potato crop, or a crop of peas, has been grown, comes in well for planting, as there is time after getting such crops off the field to allow of the necessary cultivation and the settlement of the soil. Potatoes are usually manured heavily, and when they are raised early

the land is commonly in a friable condition ; whilst the pea crop adds to the supply of nitrogen in the soil.

The first operation should be surface cultivation to kill weeds, followed, if necessary, by the application of a dressing of farmyard manure over the whole of the land. Next come ploughing and subsoiling, unless the land is to be dug with a spade, and in that case what is called bastard trenching is essential. This consists in digging the top spit in the ordinary way, and stirring nine or ten inches of the soil below with a spade or a fork without bringing such soil to the surface. Such work is usually regarded as too costly for planting on a large scale, for which the subsoiling is best done by a steam cultivator, stirring the soil in two operations as nearly to the depth of two feet as possible. Where a steam cultivator is not available, a subsoil plough, following an ordinary plough, is commonly used.

The make-shift plan of merely digging holes for trees in land not deeply cultivated is a bad one, no matter to what depth the soil in the holes is stirred. This is particularly the case where the subsoil is retentive, the holes merely becoming wells for water to drain into.

What to Plant.

Before the holes are dug it is necessary to decide what is to be planted in them. In many recently-planted orchards headed half-standard, two years' feathered, or bush apples, with gooseberries or currants between them, are grown for market purposes. In other cases two years' feathered or half-standard plums have taken the place of apples. Less frequently, tall standard apples, with bush apples or plums or pyramid pears between them, have been planted. Half-standards or bushes are much more convenient for pruning, spraying, and picking than tall standards, and for that reason are to be preferred. In exposed situations they are also less affected by wind, and can often be planted without staking, which is needed where standard trees are planted. If it be intended to cultivate a plantation with horses for some years at least, thus effecting a great saving in the labour of keeping the land clean, half-standards are preferable to bush trees. On the other hand, bush trees on the Paradise stock come more quickly into bearing than half-standards, which are usually on the crab or free stock. Again, both gooseberries and red or black currants become profitable much sooner than apples, plums, or pears, and therefore they are most commonly planted as bottom fruit, when by the time the bush fruits are worn out, or are unprofitable, the top trees will require all the space.

Distance apart, and arrangement of Trees.

The distances desirable between trees and bushes vary with the character of the soil, and, so far as trees are concerned, with strength and habit of growth. But, if horse cultivation is to be pursued, this may modify the decision as

to distances. On rich soil, full standards may be planted up to 30 ft. apart each way, whereas 20 ft. may do on poor land. Similarly, half-standards may be 15 to 20 ft. apart, according to the character of the soil and the varieties, while bush trees on the Paradise stock should be 12 ft. apart. The bottom fruit bushes should be planted at equal distances between the trees. For example, if the trees are 18 ft. or 24 ft. apart, the bushes should be 6 ft. from the trees and 6 ft. apart; if the former are 15 ft. or 20 ft. apart, the latter will be 5 ft. For horse cultivation, however, 6 ft. from plant to plant is preferable to 5 ft.

The difference between planting on the square and in angled form is shown below, + indicating a standard, and o a bush tree :—

TREES SQUARELY PLANTED.

```
+   o   +   o   +   o   +   o   +   o

o   o   o   o   o   o   o   o   o   o

+   o   +   o   +   o   +   o   +   o

o   o   o   o   o   o   o   o   o   o

+   o   +   o   +   o   +   o   +   o

o   o   o   o   o   o   o   o   o   o
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TREES ANGLED.

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+   o   o   o   +   o   o   o   +   o

o   o   +   o   o   o   +   o   o   o

+   o   o   o   +   o   o   o   +   o

o   o   +   o   o   o   +   o   o   o

+   o   o   o   +   o   o   o   +   o

o   o   +   o   o   o   +   o   o   o
```

In the case of planting bush trees, if horse cultivation is to be pursued for a time, no modification from the 12 ft. distance can be recommended, as 18 ft. would be too wide in either direction. For horse cultivation it is of great importance to have the rows of trees and bushes perfectly straight in each direction and the distances precisely kept, in order that the cultivation may be done across as well as up and down. The best way to insure this result is to mark out the field in both directions with a light plough, such as a double-breasted plough used for ridging. This should be done

at the distance of tree to tree, and then a tree hole can be dug at each place where the lines intersect, as shown above. The place for each bush hole can be determined by measuring from a tree, as the trees should be planted before the bushes. Even then, great care is needed to prevent a tree or bush from being put more to one side of the hole than the other, and frequent sighting from at least three trees off is necessary to insure straightness both ways in the rows.

If it is desired to angle the trees, so as to allow a little more distance between them across the rows, a tree and a bush may be planted alternately where the ploughed lines cross, as shown on p. 3.

A good distance for cherries is 30 ft. each way, bush plums or apples being planted between them, to stand until the cherry trees shade all the ground. Raspberries, usually grown by themselves, but occasionally as bottom fruit, may be set in rows 5 ft. apart, with 2 ft. between them in the rows. For strawberries, 3 ft. by 1 ft. 3 in. will do well. Cherries should not be manured heavily at planting time.

Varieties of Fruit to plant.

The choice of varieties is too wide a subject to be fully dealt with here. Some varieties are suitable to certain districts and soils and not to others, so that the novice should always seek local information. A local grower of experience would be able to give good advice as to the varieties which flourish best in his district, and as to the best market sorts. Again, some varieties of apples are best as standards or half-standards on the crab stock, and others as bushes on the Paradise stock. Upon these and other points sound information may be obtained of an experienced nurseryman, or may be found in the many excellent guides to fruit culture. While it is desirable for market growers to plant only a few of the best bearing and selling varieties, in order to have a good supply of each lasting for some time, it is well in starting to plant also a few trial rows of various other sorts, one row of each, with a view of planting extensively in future those which prove the best for the district, or for the local market.

Apples.—Information as to varieties of apples will be found in the Board's Leaflet No. 134 (*Apple Culture*).

Plums of excellent repute for a succession are Rivers' Early Prolific, Czar, Victoria, Belle de Louvain, Pond's Seedling, and Monarch.

Pears are not very extensively planted for market in this country, and those which are grown are chiefly early and not the choicest varieties, as but few of the better class can be relied on for regular crops. Clapp's Favourite is one of the best early pears, and Williams's Bon Chrétien is a

favourite market variety. Hessel is most largely grown in orchards near London and in Kent. Fertility, like Hessel, is a great bearer, and superior to it in quality, but a little later. Louise Bonne of Jersey is one of the most delicious September pears, and a good bearer, but not a strong grower unless on very rich or heavily manured land. Marie Louise d'Uccle, Emile D'Heyst, and Pitmaston Duchess are grown for market successfully in Kent.

Choice pears are best grown as bushes on the quince stock, when Conference, Dr. Jules Guyot, Fondante de Thirriott, Doyenné du Comice, and Durondeau should be added to the above list.

Damsons are planted at the present time mainly as shelter trees. King of the Damsons is perhaps the best variety; but the Worcestershire Prune is commonly grown in the Evesham district, and the Crittenden or cluster damson in Kent.

Cherries.—Among the most important cherries for a succession are Early Rivers, Knight's Early Black, Frogmore Bigarreau, Blackheart, Black Eagle, Waterloo, Amber Heart or Kent Bigarreau, Napoleon Late Bigarreau, Black Turk, and the Flemish Red for cooking.

Gooseberries.—Among Gooseberries, Whinham's Industry can hardly be beaten for fruiting, and Keepsake, Lancashire Lad, Crown Bob, and Whitesmith are other excellent and prolific varieties. Langley Beauty and Leveller are two large yellow free upright-growing varieties, and are to be recommended. Keepsake is the earliest to pick green, and the Yellow Rough pays well to gather for early ripe berries, while the Warrington Red is best for late sale when ripe.

Currants.—The mite has played such havoc in plantations of black currants in recent years that bushes should be obtained only from mite-free nurseries. Baldwin is one of the best varieties, but especially liable to mite or big bud infestation (*see* Leaflet No. 1, *Black Currant Mite*). Boskoop Giant is now recognised as the best and does not take the mite so freely as others. Lee's Prolific is an old favourite, but its berries are not so large as those of Baldwin, and not nearly equal in size to the Boskoop currants. New Red Dutch and Scotch Early Red are also well-known good red currants.

Raspberries.—Superlative is probably the best of all market raspberries, and a strong grower; Hornet is another good variety, superior in flavour but not equal in size to Superlative, nor does it grow so freely. Norwich Wonder and Wisbech Perfection are favourite kinds in some localities.

Strawberries.—Among strawberries, Royal Sovereign is now the chief favourite for market production, having superseded Paxton to a great extent, though the latter is still largely grown, as also are Stirling Castle and Fillbasket. Givon's Prolific is a valuable novelty in late strawberries.

In some fruit plantations, strawberries are planted between the rows of trees and bushes, to stand until they are too much shaded, or until their profitable life is ended. This plan prevents horse cultivation, and it is, therefore, preferable to grow strawberries by themselves.

An important point to be considered in relation to the planting of either raspberries or strawberries is whether sufficient hands can be obtained for picking promptly as the fruit ripens.

Planting.

Planting should not be done when the soil is in a wet condition, as it is of great importance to place friable mould over the roots. If the weather is not favourable when the trees arrive, they can be "laid in by the heels" until it is so. The first operation at the time of planting is the trimming of the roots, all parts bruised in the process of raising the trees in the nursery being cut off with a sharp knife. The cut should be made upwards from the base of the roots, so that the cut surface will rest on the soil, and the anchor or lower roots should be shortened.

When the land has been subsoiled only shallow holes are necessary, but they should be at least 3 ft. across each way for a tree and 2 ft. for a bush in order that the roots may be spread out to their full length. Nothing is more fatal to success than the mere digging of small holes and sticking in trees and bushes so that their roots are doubled up or cramped in space. The Royal Horticultural Society recommend* that the holes to be opened should be "at least 1 foot broader than the roots cover." If the land has not been subsoiled the bottom of each hole should be broken up to the depth of 10 inches, a little of the top spit thrown into the middle and the tree planted on it.

If standards or half-standards are to be planted, strong stakes will be required, not less than 7 ft. long for the former or 6 ft. for the latter. If placed exactly in the centre of each hole the stakes will be in straight lines, and the trees tied to them must be so also. It is much easier to drive in the stakes before planting than afterwards, besides which possible injury to the roots of the trees is then avoided.

In planting, one man should hold and place a tree, spreading out all the roots so that their ends slope slightly downwards, while another spreads finely-divided soil over them, moving the tree gently up and down to work the soil

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* **Varieties of Fruits, 1906 Edition, Revised, p. 10.**

well among the roots. The earth in the hole should be a little higher in the middle than towards the sides, to allow of the roots being spread well without being turned upwards. After some of the soil has been thrown in, upon poor land a forkful of manure may be placed upon it, and the hole may then be filled up, being slightly rammed during the process, and trodden firmly, but not hard, at the finish. Dung should not be placed directly on or in contact with the roots, and in soil well manured for a previous crop manure should not be placed in the holes at all at planting time. It is best used as a mulch in the following summer, but a layer placed round each tree on the surface after planting is of much value. The trees should be so planted that they will be of the same depth in the soil after it has sunk as they were when growing in the nursery. On heavy land it is important to guard against too deep planting. Planting almost on the surface of heavy land, with small mounds of earth over the roots, is sometimes recommended; but this is a questionable practice, as the earth is almost certain to be drawn away from the trees in hoeing, even if it be not washed away by heavy rain, leaving the roots insufficiently covered for a droughty season.

Shelter.

In exposed situations it is of great importance to provide shelter against prevailing winds, and where planting is to be done by instalments, extending over some years, it is advisable to put in shelter trees beforehand—the sooner the better. The Italian poplar is one of the quickest-growing of trees, and for this reason it is extensively used for shelter. Its chief defect is that it is deciduous. On the other hand, evergreens are of much slower growth. The Austrian and Scotch pines are frequently recommended, as they form excellent shelter. A much more speedy grower is *Cupressus macrocarpa*, which is one of the best shelter trees for the south-western counties of England. In the bleaker north it is liable to be killed by frost, and there the *Cupressus Lawsoniana* or Corsican pine may be recommended instead. *Pinus insignis* is useful for Cornwall and Devon. A single row of trees is not a sufficient windbreak where gales are violent, and it is a good plan to plant a triple row: damsons inside, *Cupressus* trees in the middle, and Italian poplars outside.

Besides tall trees as windbreaks, the lower shelter of a dense fence is desirable. On most farms hedges are already provided, and these can be allowed to grow at the top, regular annual brushing tending to thicken those which are gappy or thin at the bottom. For making a new fence quickly, or for filling up gaps, the Myrobalan plum is one of the quickest of growers; it may be made to grow densely by early pruning and subsequent brushing, but it does not like heavy soil. (*See* also Leaflet No. 147, Fences and Hedges.)

General.

With respect to the extent of planting at any one time, it is desirable to point out that the capital required for extensive operations is considerable. It is not only the expense of preparing and manuring the land and the purchase and planting of trees and bushes that have to be estimated. At least as much should be allowed for the annual loss on a plantation before it comes into profit, this usually being five to six years after planting for standards and half-standards. In the meantime the expenses of cultivation, spraying, pruning, manuring, picking, and marketing, with rent or interest on capital, rates, and taxes, will often considerably exceed the returns. No fixed estimate of the amount of capital that must be sunk can be given, as it will vary with the condition of the land, the age or stamina of the trees and bushes when planted, and the care and good judgment exercised in their treatment.

Bush fruit begins to pay the third year, and apples on Paradise stock may give a fair return the second or third year.

It is desirable to warn inexperienced planters against the purchase of very cheap trees and bushes at auctions, or as offered in advertisements, unless they are found, on inspection, to be well up to the mark. Weak or stunted trees or bushes are dear at any price. On the other hand it is not desirable to pay extra prices for large trees or bushes, as those which are two to three years old commonly do best.

Whitehall Place, London, S.W.1,
October, 1905.
Revised, February, 1908.

Leaflet No. 149.

BOARD OF AGRICULTURE AND FISHERIES.

Threshing of Barley.

Injury due to bad Threshing.

Complaints are frequently made by brewers and maltsters of the injury done to barley in the process of threshing, owing to the fact that the drum of the threshing-machine is set so close that many of the grains are cracked or broken. The presence of such injured grains greatly reduces the value of the barley for malting purposes, as the broken, bruised or skinned grains fail to germinate, and soon show signs of mould, thus leading to unsoundness in the malt and bad results in the brewery. The injury caused by over-dressing is not limited to grains which are actually broken, as grains closely nipped at one or both ends, or such as have been bruised and peeled, are equally objectionable. In fact, if by too vigorous threshing the husk of the barley is damaged, although the damage may not be apparent, irregularities in the malting, accompanied by the production of mould, are likely to result.

To prevent Injury.

(1.) When farmers commence a day's threshing they should at the outset, and repeatedly during the day, carefully examine the grain. If any signs of injury are observed the concave of the drum of the machine should be slightly opened. It is better that part of the beard should be left adhering to the grain than that any risk should be run of injuring the reputation and value of home-grown barley on account of broken and chipped grains.

In this connection, Mr. Baird, a leading maltster in Scotland, in an article on the Overdressing of Barley, which appeared in the *Transactions* of the Highland and Agricultural Society in 1902, pointed out that if in order to get all the grain out of the ear, especially when the barley is difficult to thresh, the drum and concave are set too close, there is obviously more danger of breaking and "nibbing" than when they are not so closely set.

(2.) A new machine will break the grain more than a machine which has been used for a time and in which the roughness of the beaters has been worn off. On the other hand, when a machine has been much worn, the centre of

the drum and concave having had the most work, in consequence of the feeding being necessarily more in the centre than at the ends of the drum, the space between them is greater in the centre than at the two ends, and if they are set to thresh clean in the centre they will be too close at each end, and consequently damage will occur. This fault can only be remedied by putting on new drum-beaters and concave ribs.

(3.) Great attention should also be paid to regularity of feeding. The mill should be driven at an even speed, and proper care should be taken in the adjustment of the several parts of the machine.

(4.) It is not only in the drum of the threshing-machine that unnecessary damage to the kernel takes place through imperfect setting of the several parts, but also in the barley-awner or hummeler, through which the grain subsequently passes. Here, if the beaters are set too closely, and the barley is roughly handled, "nibbing" will take place.

Different varieties of barley require different treatment, so that those in charge of the threshing should make a point of constantly examining the sample, and if this is injured in any way, of ascertaining in what part of the machine the injury occurs, altering the setting until it is remedied.

(5.) As a further guide in threshing it may be added that on no account should the barley be rushed through the machine, as it is better to be content with a moderate output and a more perfectly threshed sample.

(6.) Heavy bushel-weight is no longer required by maltsters, and such barley does not command a higher price, grain of moderate weight being preferred to a sample of heavy weight. This may be emphasised by stating that barley weighing naturally from 54 lb. to 56 lb. per bushel is preferable to barley weighing 56 lb. to 58 lb. per bushel.

(7.) It is important that the machine should be thoroughly clean in all parts before commencing the day's threshing.

Whitehall Place, London, S.W.1,
August, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 150.

BOARD OF AGRICULTURE AND FISHERIES.

PEA AND BEAN BEETLES.

1. The Pea Beetle (*Bruchus pisi*).

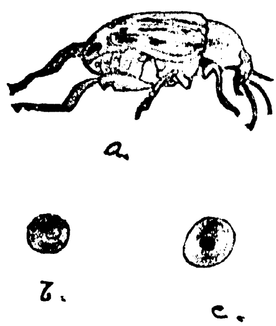

Fig. 1.—*Pea Beetle*—*a.* Beetle, × 5 (after Curtis). *b.* Infested pea showing position of beetle. *c.* Hole left in pea after exit of adult beetle.

This beetle attacks peas only, although the closely allied species, *Bruchus rufimanus*, attacks the bean in a similar manner. There are records of the adult beetle injuring the foliage of young pea plants by feeding on the leaves, but it is the larva or grub which is the real cause of the damage complained of in connection with this insect. The grubs live in the seed and the result of their work is that the seeds may not germinate, or if they germinate the plants from them may be weakly. Inferior peas imported for feeding birds, pigs, &c., are frequently very badly infested and help in adding to the numbers of the beetles and in spreading them.

Description.

The beetle (Fig. 1, *a.*) is oblong-oval in shape and black in colour, with a brownish or brown-grey pubescence. The four basal joints of the antennæ are red, as are also the shanks and tarsi of the two front pairs of legs. The thighs (femora) of the front legs are black, or almost so, whereas in the allied *B. rufimanus* the thighs of the front legs are red. The

thorax is slightly narrowed in front and has a distinct white spot behind. The wing covers are rather short, so that the hinder part of the abdomen is exposed; this exposed part has a greyish-white pubescence, with dark spots, of which two large ones at the tip are marked. The hind legs are longer than the others and have the femora stout and toothed.

The larva is whitish-yellow in colour, fat and wrinkled. When newly hatched from the egg it has three pairs of small legs, which are afterwards lost. The scaly head is provided with gnawing jaws.

Life History.

The adult beetles lay their eggs on the pea pods when these are very young. The larva or grub on hatching bores into a pea and here finds nourishment sufficient to develop it to its full growth. When full grown, the larva pupates in the pea, having first eaten its way to the outer coat of the pea, so that when the beetle is mature after pupation and is ready to issue it has only to break through this thin skin. Beetles may issue in the autumn and pass the winter in some place of shelter, or they may issue in granaries and stores and shops during or after the winter, or from the peas after these have been sown. The beetles fly well and can thus pass to other pea crops.

2. The Bean Beetle (*Bruchus rufimanus*).

This beetle has habits similar to those of *B. pisi*, inasmuch as the grubs live in the seed,—in this case in the bean—where their presence is harmful because of the interference with and possible prevention of germination.

Description.

The beetle (Fig. 2, *a.*) is about one-sixth of an inch in length. Black in ground colour, with a pubescence of brown hairs, it has a great resemblance to *B. pisi*. The Bean Beetle, however, can be distinguished by the thighs of the front legs, which are red, and also by the fact that, the exposed tip of the abdomen being nearly covered with white-grey pubescence, the dark spots characteristic of *pisi* scarcely show in *rufimanus*, or may not show at all.

The larva (Fig. 2, *b.*) is whitish, fat, and wrinkled, resembling that of the Pea Beetle.

Life History.

The beetles after pairing lay their eggs on the very young pods in the field, making their way into the blossom for the

purpose. Out of each egg hatches a whitish wrinkled grub which bores into a bean, nourishing itself till full-grown on the reserve matter in the seed. More than one grub may be found in a bean, two and three being very common numbers. The full-grown grub pupates in the bean, and in the spring, or earlier, the adult beetle emerges. The round hole shows the place of emergence; in beans still containing the beetle a little round patch on the outer skin of the bean marks the place where the beetle lies.

General Preventive and Remedial Measures.

(1).—Peas containing the pest should not be sown. It has been stated that attacked peas can be separated from healthy

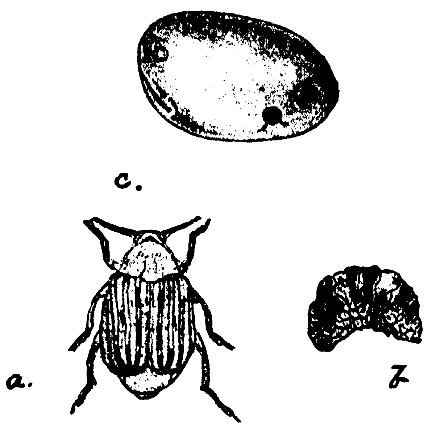

Fig. 2.—*Bean Beetle*—*a.* Beetle, × 5. *b.* Larva, × 5. *c.* Bean showing issuing beetle.

ones by placing the sample of peas in water, when the healthy ones will sink while the infested ones float. This statement is not wholly trustworthy. In experiments with sound and attacked peas it has been found that healthy sound peas sink at once, but that peas with holes in them from which beetles had issued, and those with the outer skin broken but with the beetle still *in situ*, might float for a short time, but ultimately they all sink. On the whole, peas with the outer skin unbroken and containing the beetle continue to float.

(2).—The best mode of killing the pest in the pea or bean is by fumigating these with bisulphide of carbon. The method is to enclose the peas (or beans) to be treated in an air-tight chamber, and then to place bisulphide of carbon in saucers or shallow dishes laid *on the top* of the peas (or beans) and

allowed to remain for 48 hours at least. Two pounds of bisulphide of carbon will do for 1,000 cubic feet of air space. A very important condition is the temperature. Hinds and Turner and also Chittenden have shown in experiments with other grain-infesting beetles that a temperature of 70° to 75° F. is necessary for success. Bisulphide of carbon fumes are poisonous and easily inflammable; they should therefore not be breathed by the operator, nor should a naked light of any kind be brought near them.

(3).—If at the time of sowing live beetles are noticed in the peas, the beetles will be killed if the peas are dipped for 5 seconds into boiling water. The peas so treated may be sown after being dipped in cold water.

(4).—If infested peas and beans be placed in a closed jar or other vessel the beetles will in due course issue and will die without further harming the seeds. Though such seeds will germinate, they cannot be relied upon to produce strong plants, and it is therefore best not to sow them.

Whitehall Place, London, S.W.1,
November, 1905.
Revised, June, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 151.

BOARD OF AGRICULTURE AND FISHERIES.

Cleanliness in the Dairy.

Milk is perhaps at once the most nourishing and the most delicate of all foods; nourishing because it supplies all the constituents necessary to support life, and delicate because in practice its character gradually changes from the moment it leaves the udder of the cow. These changes are chiefly induced by micro-organisms; and as cleanliness is the main factor by which the number and species of such organisms may be kept under control, cleanliness in the handling of milk and its products is of the utmost importance.

Except that portion first drawn from the teat, milk as it exists in the udder of a healthy cow may be considered to be practically free from germ-life. After reaching the milker's pail, however, it usually contains a considerable number of those minute forms of life known as germs, bacteria, or microbes. With proper precautions perfectly sterile milk may be drawn from the udder of a healthy cow, but in ordinary practice milk is more or less exposed to bacterial contamination, and this is the reason that souring and other changes take place.

If the very best milk for keeping purposes is required that first drawn from the udder should not be mixed with the bulk, as it always contains injurious bacteria. Milk from cows which are obviously unhealthy should never be used for human consumption, but may be given to poultry, calves, or pigs *after boiling*. Pure, clean raw milk from *healthy* cows may be considered much better for general consumption than milk which has been pasteurized or sterilized, especially when consumed while still warm.

Of the organisms which find their way into milk it may be said that they belong to the smallest forms of plant-life, which find milk to be a very suitable food and a medium in which they multiply rapidly, the increase being especially rapid when the milk stands for a time in a warm place after being drawn from the cow. There are many species of these organisms, all of which are more or less distinguishable either by their form, their habits of growth, or the effects which they produce. The products of these organisms have a peculiar chemical action upon one or more of the constituents of the milk which may affect the whole. For

example, a lactic bacterium secretes a substance which acts on the milk-sugar, thereby producing lactic acid; this acid in turn acts on the casein, forming curd. The objectionable flavours that are so frequently found in milk, butter, or cheese, are also usually due to various specific organisms.

Sources of Bacterial Contamination.

The chief sources of contamination of milk are dirt and dust on the cow, the milker, the air, the water supply, the hay, and the dairy utensils. The cow herself is one of the most fruitful sources; not that she secretes milk containing germs, but because these germs exist on the hair which covers her body, and many of them during milking are in some way carried into the milk. A cow kept in a dirty, badly-kept or ill-ventilated byre is rarely clean; her exterior, especially about the udder and hind-quarters, becomes more or less covered with dust and dirt, on which germs multiply, consequently increasing the number of organisms which fall into the milker's pail. The milker's hands and clothes, which in many cases are none too clean, are also fruitful, and at times dangerous, sources of infection.

The atmosphere of a cow-byre, moreover, is in too many cases confined, and consequently impure; such an atmosphere contains a large number of bacteria, which, being slightly heavier than the air, gradually settle down, and some of these are conveyed into the milk or into the utensils waiting to receive it.

Milk readily absorbs bad flavours and odours from surrounding strong-smelling substances, and proximity to anything of such a nature should be avoided.

Finally, the dairy utensils are frequently a source of contamination, either owing to improper cleaning or because they are left after cleaning in places where they are exposed to infection. Dairy utensils should, wherever possible, be perfectly tinned; they should be as few in number as convenient; and they should be simple in construction. For example, the Danish style of milk can, with close-fitting lid which *throws off* rain water, is very much better than the ordinary English railway "churn."

Figures 1–6 illustrate the very material differences which exist between dirty and cleanly cows, pails, and byres. The plate cultures derived from the impure sources contain many more "colonies" of organisms than those derived from the cleanly sources.

Cleanliness in the Management and Housing of Cows.

Efficient ventilation is, perhaps, the first essential to a good cow-shed or byre. A properly ventilated cow-shed is

FIG. 1.—Photograph of a gelatine plate exposed for one minute in a badly ventilated cow-shed.

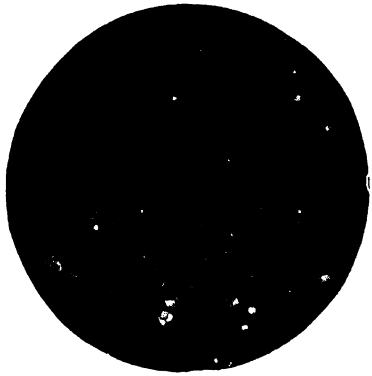

FIG. 2.—Photograph of a gelatine plate exposed for one minute in a well-ventilated cow-shed.

FIG. 3.—Gelatine plate exposed for one minute during milking under a dirty cow.

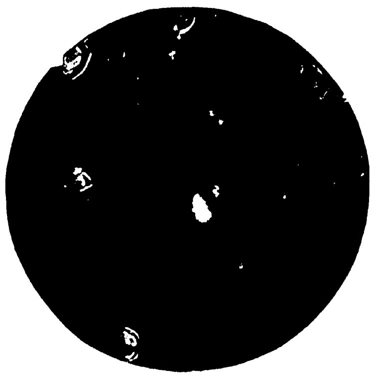

FIG. 4.—Gelatine plate exposed for one minute during milking under a clean cow.

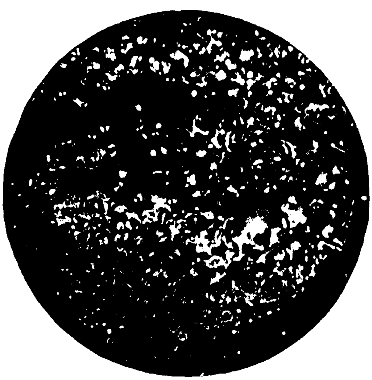

FIG. 5.—Plate culture made from milk drawn into a dirty pail.

FIG. 6.—Plate culture made from the same quantity of milk drawn into a clean pail.

one in which fresh air is constantly supplied without causing a draught. The question of efficient ventilation and the construction of cow-houses generally is dealt with in Leaflet No. 241 (*The Construction of Cow Houses*). The walls, beams, and rafters should be regularly swept down and frequently lime-washed; above all, cobwebs and dust should never be allowed to accumulate. The cow's bed must be kept clean at all times, and the manure and soiled bedding should be removed from the shed at least twice each day. Any manure adhering to the cow after she has been lying down should at once be removed. During the winter, when she passes most of her time in the shed, the cow should be brushed down each day *after* milking. Where this is done the bacterial contamination of the milk is sensibly decreased, *but cleaning and brushing should neither take place when milking is actually in progress nor immediately before.*

The hair on the udders and hind quarters of the cows might usefully be clipped in autumn when first taken into the stalls at night, or as they calve. Clipping the udders has been practised on one farm for thirty years, while the hind-quarters have also been clipped for several years, and the plan has been found a great aid to cleanliness. When a power clipper is used it is not so tedious a matter as may be supposed. In the case referred to about 200 cows are dealt with in this way.

The gangway and gutter behind the cows should always be kept clean, and it is important that they should be in their cleanest state at milking time. The material composing the floor of the gangway and gutter should be impervious to moisture, otherwise it may harbour organisms which, if carried into the milk, may be the cause of considerable trouble. Openings of drains from cowsheds should always be placed outside the building.

It is not desirable to confine the cows entirely in the sheds during the winter; they should be given at least an hour in the open each day, for few things are equal as disinfectants to daylight and exercise.

Cows should on no account be allowed to consume hay or dusty fodder during the time milking is in progress, as both contain countless organisms.

Too much attention cannot be given to the drinking water. It is to be regretted that in many cases the cows have access only to a stagnant pond, into which they must wade before sufficient depth is attained to enable them to drink. When drinking, cows are apt to void excreta with results that may be imagined should such material fall

into the water, as it too often does. Such a state of affairs should be remedied at once, and *ponds should be fenced in*, the water being drawn by a hand pump into a drinking trough outside the fence. Even if the droppings of cows are excluded from the drinking place, stagnant water is certain to be crowded with bacterial life, so that, apart from the risk to the cow's health, the chance of trouble with the milk is greatly increased by allowing the cows access to such a pond. There are many ways by which the bacterial life of a stagnant pond may gain access to milk, but probably the most common way is by means of the organisms carried out of the water on the exterior of the cow, and which at milking time may fall into the milk. The evil of this will be realised when it is remembered that among the bacterial life of any pond may be found, almost without exception, many organisms capable of bringing about injurious changes in milk, butter, or cheese. The ideal watering-place is a running stream of pure water so protected that cows cannot wade into it, or a trough through which such water passes. Where no such stream exists every endeavour should be made to approach the ideal as nearly as possible, and if it is necessary for the cattle to drink water that is more or less stagnant, matters should be so arranged that they can obtain what they require *without being able to stand in the water.*

It is best not to milk cows while they are dripping with rain water. This is probably a frequent source of bacterial contamination.

Dairy farmers, and especially those engaged in cheesemaking, should be most careful not to allow poultry in and about the cow-sheds, or to have access to hay and straw used as food for the cattle. Droppings of poultry are a little-recognised but fruitful and frequent source of contamination. They teem with bacteria injurious to milk, and are often responsible for excessive fermentation or "sponginess" in cheese curd.

Cleanliness in Milking.

If the best is to be made of the milk after it has been drawn, it is necessary to observe the strictest cleanliness in connection with the operation.

In order to prevent contamination of the milk *everything should be at rest within the byre at milking time, that is to say, there should be no shaking of bedding or feeding of the cows.* The whole place should be clean and sweet, and quiet. Shortly before milking begins someone with a clean, rough, dry cloth should be sent to wipe each cow's udder. If any cow's udder is found to be soiled in such a manner that it cannot be cleaned in this way it should be washed. The practice of washing the udder was attended with no ill

effects in the Yorkshire experiments.* After washing, the udder must be carefully dried, otherwise the cow might get cold in one or more quarters of the udder.

Each milker should thoroughly wash his or her hands and arms before commencing to milk, and particular care should be taken to see that the milker's clothes are clean and suitable for the purpose. This may be best assured by insisting that each one wears a smock or blouse which has not been too long absent from the wash-tub. All milkers and employés should be healthy and free from infectious disease.

As soon as the milk of each cow has been drawn, it should be taken outside the cow-shed and passed through a strainer, consisting of muslin resting on a fine wire gauze, and then removed to the dairy as quickly as possible. The use of thick heavy cloths for straining purposes is to be condemned, as they are liable to be very imperfectly cleansed. Numerous cases of "fishy" flavour and rapid souring in milk have been traced to the use of such cloths. Straining should take place before cooling, which should be done as soon as possible after milking, and invariably in a pure atmosphere. It is advisable to rinse the cooler with boiling water and then with pure cold water immediately before the milk is passed over it. The milk should be cooled to 50° F. It is a great mistake to allow milk to stand about in the cow-shed, as is often done, for this only serves to contaminate it further.

Milking with wet hands is an objectionable practice. The cows should be stripped of their milk thoroughly and quickly by dry-milking. Apart from the fact that no dirt is so difficult to remove from milk as that which enters in a liquid or semi-liquid form, the act of wet-milking leaves the teats covered with a film of milk on which germ-life immediately begins to multiply, and as that film of milk dries, the germs become more or less firmly attached to the teats, only to be removed and washed into the pail at the next milking. In dry-milking, it is sometimes an advantage if a little vaseline is rubbed on the milker's hands before beginning work.

Experiments* with two of the best modern milking machines showed that they were a source of great contamination, owing both to the difficulty in cleaning them and to the sucking in of air and dust when the cups fall off.

Importance of Cleanliness.

(1.) *In Dairy Utensils.*—Vessels used for the reception of milk should be absolutely unabsorbent, otherwise it is

* *See* "Report on an Investigation as to the Contamination of Milk," carried out on behalf of the County Boroughs of Bradford, Hull, Leeds Rotherham and Sheffield, and the Administrative Counties of the East and West Ridings of Yorkshire, 1908. Copies of this Report, price 2*s.* 6*d.*, can be obtained from the Clerk of the Council, County Hall, Beverley.

impossible to clean them thoroughly. If, for example, warm milk is put into a dry wooden vessel, the heat of the milk causes the air in the wood to expand, and so drives out a portion of it; and afterwards, as the milk and the vessel cool down, milk is sucked into the wood to replace the air previously expelled. When milk has once entered into wood it is a most difficult matter to remove all traces of it, the result being that the portion which almost invariably remains acts as a food for germ-life. To obviate this, wooden milk vessels, if used at all, should always be thoroughly saturated before being used to receive milk, by first placing them in hot, and afterwards in cold, water.

In the majority of dairy utensils tin is the surface with which the milk comes in contact. Such utensils are excellent, provided that all joints are properly made and that all parts are readily accessible for cleaning; all should be cleaned immediately after use, and on no account should milk be allowed to dry upon them. The cleansing may be best accomplished by first washing them in cold or slightly warm water, afterwards using hot water and a stiff brush, which is much better than a cloth. The utensils should finally be rinsed in boiling water. If steam is available, and the vessels can be put over a steam jet, so much the better. The hotter the final rinsing or steaming, the greater the likelihood of all forms of germ-life being killed. After cleansing, milk vessels should be left in an airy position with the mouth or opening turned downwards, but in such a manner that the air has unrestricted access. Parts which are not easily accessible should be washed with lime water occasionally.

(2.) *To the Milk Seller.*—To both wholesale and retail milk sellers all forms of germ-life are objectionable, for if they wish to retain their customers it is necessary to produce milk which not only meets the requirements of the standard of quality, but retains its freshness as long as possible. The dairy or shop should be pure and clean, and well ventilated, but protected from dust, &c., while water employed for any purpose should be quite pure. The keeping quality of milk is mainly determined by two factors: (1) the amount of germ-life contained in it; (2) the temperature at which it is kept. The latter factor is, in reality, only a part of the first, since the rapidity of the multiplication of germ-life is dependent on temperature. For this reason milk to be sold as fresh milk or milk which has to travel any distance, should invariably be run over a cooler in order to lower its temperature, and should be kept at a temperature not exceeding 50° F., ice being used if necessary.

In the retail trade all stale milk, or milk left unsold, should be kept quite apart from fresh or warm milk. All milk to be sold should be kept well stirred and the vessels

kept covered. If the trade is in *warm fresh milk*, then especial care is necessary in its production and management.

During hot or dusty weather, floors and their surroundings should be sprinkled with clean cold water.

(3.) *In Butter and Cheese-making.*—It is not going too far to say that cleanliness is absolutely essential to the successful making of first-class butter and cheese. In butter-making pasteurization of milk is possible, but for the cheese-maker it is not practicable. For cheese-making, therefore, especial care is necessary in the production and handling of the milk. Unlike the milk seller, to whom all forms of bacterial life are objectionable, the maker of dairy produce has to depend on certain forms of germ-life to perform vital functions in the processes by which milk is transformed into butter or cheese. In cheese-making, milk may be compared to a field free from weeds, the cheese-maker sowing in the milk those cultures of the ferments or bacteria which he wishes to grow, and which produce the desired flavour. Butter-makers often nullify all anterior efforts to avoid contamination by washing butter in the churn with impure water, or by packing butter in bad paper or in unsuitable packages. Yet experience teaches that wherever uncleanliness exists there also will be found a large number of germs which, by their action, are almost certain to prevent the successful manufacture of dairy produce. Indeed, it not infrequently happens that, owing to the uncleanly management of the cows, uncleanly milking, or uncleanly utensils, the possibility of making the finest butter or cheese has been destroyed before the milk has even reached the dairy.

Whitehall Place, London, S.W.1,

July, 1905.

Revised, March, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

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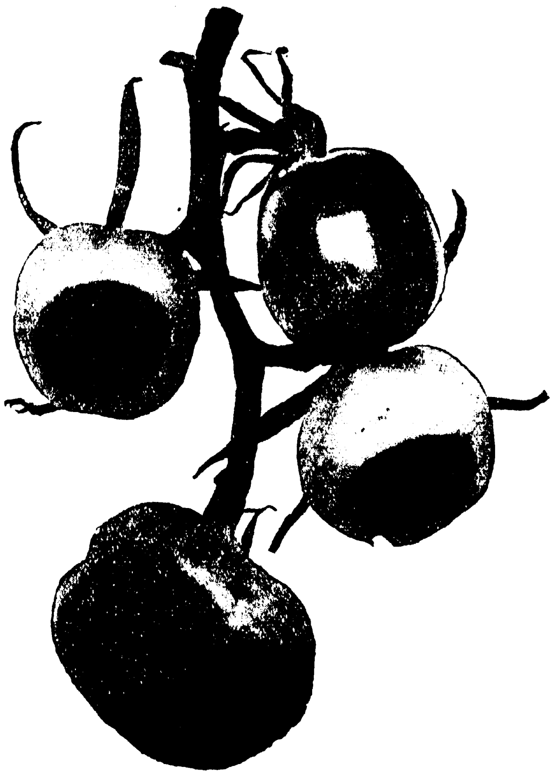
Leaflet No. 152.

BOARD OF AGRICULTURE AND FISHERIES.

Bacterial Disease of Tomatoes.



BACTERIAL DISEASE OF TOMATOES.

This disease has long been known in France, where during certain seasons, it has assumed the proportions of a destructive epidemic. A single example was received at Kew some years ago for identification, since which time until the present season its occurrence in this country has not been noted. Quite recently, however, examples of the disease

have been received from three widely separated localities which suggests that it has invaded this country in earnest.

The symptoms are very marked and cannot be confounded with those of any other tomato disease at present known. When the tomato is about the size of a marble a minute blackish patch first appears at the base of the style. This patch gradually increases in size, retaining a circular outline, until eventually the entire fruit is reduced to a blackish, soft decayed mass.

Experiments have shown that infection takes place during the flowering stage, and that the bacteria causing the disease are deposited on the stigma by flies visiting the flowers.

The stigma appears to be the only vulnerable part under ordinary conditions; nevertheless, if bacteria from a diseased fruit are introduced into the flesh of a healthy tomato at any point of its surface by means of the point of a very fine needle, infection follows.

This disease does not appear to be influenced to any extent by the forcing method of cultivation commonly followed, as it has been observed in a house where the temperature was kept comparatively low.

When the disease appears all diseased fruit should be removed as quickly as possible, and not be allowed to decay and liberate the bacteria present in the tissues. Insects should also be excluded by using an insecticide. This last act would necessitate artificial pollination with a camel-hair brush.

Whitehall Place, London, S.W.1,
October, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

11397 N 2

Leaflet No. 153.

BOARD OF AGRICULTURE AND FISHERIES.

Storing Turnips.

The main reason for storing turnips is to protect them against damage by frost, though protection against ground game, rooks and wood pigeons, which may be very hard on roots exposed during winter, is also an important object in some districts. Not only should a good system of storage secure these ends, but it should also protect the roots against decaying and becoming too dry.

Methods of Storing Turnips.

The more important methods of preserving turnips over winter are as follows :—

1.—In large heaps, whose length and breadth will depend on the quantity of roots to be stored, but whose depth should not exceed 3½ ft. The sides are covered by some 12 in. of straw, overlaid by 4 in. of soil on the sides exposed to the prevailing winds, though 3 in. of soil will suffice on the other sides. The top of the heap is covered by 6 in. of straw kept in position by poles, branches, &c. Old straw ropes removed from stacks that have been thatched may be usefully thrown over the straw. Soil should not be spread on the top of the heap, as it gets washed through amongst the roots and dirties them.

2.—In oblong heaps, like large potato pits or clamps. The base should have a breadth of 7 ft., and on this the roots are piled, gradually contracting to the top like the roof of a house. The whole is afterwards covered by some 12 in. of straw, overlaid by 4 in. of soil on the side exposed to the prevailing wind. On the sheltered side the covering of soil should not exceed 2 in. in depth. Many farmers do not place a complete covering of soil on the sheltered side, but only a spadeful of soil on every square foot. The ridge of the heap is, in any case, left clear of soil, so that free ventilation is secured. This style of heap requires more covering in proportion to its contents than the last, but under no system of storing are the roots better preserved.

3.—In small heaps, equally distributed over the field where the roots were grown. Each heap usually contains about 30 cwt., but in some districts, heaps containing only about half-a-ton of roots are formed, in which case, if the

crop is a good one, no carting is necessary, the roots being simply thrown together by hand. The size of the heaps should be regulated by the size of the flock consuming them, the object being to provide a day's supply in each heap. Thus, with a flock of 200 sheep getting 20 lb. per head per day, about 35 cwt. would be daily required, and this would approximately represent the contents of each heap. The troughs would be moved each morning to a fresh heap, and thus the field would be evenly manured. Should the turnips in these heaps be required within a few weeks of storing, they are usually only covered by the tops, kept in position by a few spadefuls of soil, but for longer storage a covering of straw and soil is necessary. Turnips seldom go wrong in such heaps, which have the additional advantage of being quickly formed. They are specially useful for roots that are intended for consumption by sheep in spring on the land where the crop was grown.

4.—Laying two rows in one, and ploughing in, is an excellent method of storing roots on light dry land. Under this system the roots are not only well protected, but they are also placed under conditions that admit of their growing considerably if the winter is mild. The method of procedure is as follows:—The row is divided into four equal lengths, and a worker is assigned to each. An ordinary single mould-board plough opens a deep furrow close to the first row, throwing the soil outwards. The first worker then proceeds to lay the roots (with tops and tails attached) of the two adjoining rows into the furrow, and the plough on returning throws the earth back on the roots, leaving only the tops of the leaves exposed. Other two rows are then similarly dealt with, and so the work proceeds across the field. In spring, when required, the roots are lifted by ploughing up, dry weather being selected for the operation.

5.—If labour is scarce or work is pressing, considerable protection may be given to growing roots by merely running the double mould-board ridging plough between the rows. In this way the roots, if not very large, are fairly covered, though not so thoroughly as by the previous method.

6.—"Planting," as it is called, is practised locally in the North of England, and is regarded as the best way of preserving turnips for the use of lambing ewes. The turnips grow considerably when stored in this way, and in spring possess a well-developed top, which is considered excellent for the production of milk. A dry well-sheltered stubble field, or a grass field that it is intended to break up in spring, is selected, and in October or early in November the roots are carted to it and placed in a single layer in their natural position, without topping or tailing. No protection is given, except along the sides, against which a furrow is laid. The only drawback to the system is that it entails the use of a large area of ground.

7.—A favourite system on the Borders, where turnips are wanted for ewes in spring, is to cart the roots, with tops and tails attached, to a grass or stubble field, on which they are laid what may be called "cart-thick," that is to say, about 2 ft. deep. By means of a strong rake or muck-hawk the roots are levelled out, care being taken to get the tops of the uppermost roots on to the surface. A furrow run round the clamp is sufficient protection. Roots stored in this way are found to be specially juicy and fresh in spring, and this system of storage has the additional advantage of being rapid and economical.

Points to be observed in Storing Turnips.

The following points should be generally observed in storing turnips :—

a.—A dry open situation should be selected on which to place the heaps. Although proximity to a wood or hedge may secure shelter from cold wind, roots often keep much worse under such circumstances than in an open exposed place.

b.—The roots should be dry and clean when carted. If topped and tailed, the operation should be conducted so as to injure the bulb as little as possible.

c.—The turnips should be well matured before storing. This is indicated by the lower leaves being yellow.

d.—It is a good plan, weather permitting, to leave the roots lying in the field, after topping and tailing, for three or four days before carting. This hardens the skin, and brings them into better condition for storing.

e.—Unless frost threatens, soil should not be put on the heaps for at least a week after the roots are carted. This permits of the circulation of air and escape of moisture.

f.—A word of warning must be uttered as to the danger of spreading finger-and-toe by means of stored turnips. Roots with any suspicion of the taint of this disease should not be consumed on tillage land, but should be carted on to permanent pasture. Further information on this subject is contained in Leaflet 77.

Whitehall Place, London, S.W.1,
August, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Foot Rot of Sheep.

There has been, and still remains, among flockmasters, shepherds and others a good deal of diversity of opinion as to whether foot-rot of sheep ever constitutes a contagious disease, *i.e.*, a disease communicable from a diseased sheep to a healthy sheep, or not.

This difference of opinion appears to be mainly due to the fact that almost any diseased condition affecting the feet of sheep, associated with lameness, is usually classed under the general and ambiguous term foot-rot, and in that way non-contagious affections of the feet of sheep, causing lameness, have supported the view of some observers that foot-rot of sheep is not a contagious disease.

NON-CONTAGIOUS FOOT-SORE.

It is important to recognise that in a flock of sheep several animals may be simultaneously lame from injury to the feet, and the disorder show no tendency to spread through the flock. Such a condition, however, is not true foot-rot, although the injured feet may present ugly sores. It would be better described as foot-sore.

The non-contagious form, or foot-sore, which is due to injury to the foot, has its starting point usually in the horn itself. The horn may be decayed, broken, cut or bruised, and, through the opening in the horn, soil and filth gain an entrance and set up inflammation of the sensitive structures of the foot, from which pus is usually discharged.

Among the conditions which predispose to this form of foot-sore may be mentioned the continual grazing of sheep on low-lying marshy pastures where the grass is long, particularly during prolonged wet seasons and neglect of attention to trimming the horn, which under such adverse conditions becomes overgrown, gives an uneven treading surface, and is very liable to become soft and even decayed. Injuries may be inflicted by the animal stepping on sharp or rough objects, such as sharp stones, glass, nails, thorns, &c., and by over-trimming of the feet. They may also arise from travelling sheep for long distances on hard roads, or from anything which causes a breach in the horny foot, or bruises the sensitive foot, especially when the horn is worn or thin.

Symptoms.

The non-contagious foot-sore is the commoner condition met with, and it is not unusual to find one or more sheep in a flock affected. Although lameness may not be a marked symptom from the first, yet it is usually the first indication to the shepherd that there is anything the matter with the

foot, and by this time in such cases, the lameness denotes that inflammation and suppuration have set in.

It will be observed, with perhaps rare exceptions, that in this non-contagious affection the disease has commenced at or near the under surface of the foot, and that the destructive process extends from below upwards. If pus forms and remains imprisoned within the horny box it will burrow and work its way towards the softer structures of the coronet as a way of exit, because the softer structures offer the least resistance to its progress. The foot becomes swollen round the coronet; it is hot and tender, and one or more small abscesses may appear on the coronet or heels. These abscesses burst, and discharge thick pus, which is frequently mixed with a little blood. The parts may continue to discharge pus, or they may heal up, but even when the outer wound is apparently healing and is closed by a layer of coagulated exudate on its surface, the pus may again be imprisoned, with the result that abscesses appear at other parts of the coronet. Providing there is an exit for the pus at the lower surface of the foot these secondary abscesses will not occur, since the pus, as it is formed, is continually discharged from the opening, which affords a natural drainage to the matter within the foot. If after the injury an outlet through the horn remains for the escape of pus, the case may recover in a few days without any treatment. On the other hand, if the breach in the foot is too small and does not allow the free escape of the pus, suppuration continues. Granulation tissue and new horny material are formed, and the former grows out from the sensitive parts in the form of what is commonly called proud flesh, from which a continual discharge oozes. The sore bleeds easily, and the foot becomes distorted.

Treatment.

By carefully trimming the foot, cleansing the wounds with antiseptics, applying a dressing if necessary, and removing the affected sheep to drier pastures, the flockmaster will enable many cases promptly to recover. In those cases where the injury has been aggravated by extensive suppuration the feet require careful and repeated individual attention. It will be found that although the non-contagious affection is the commoner, it usually affects only a comparatively few animals in a flock, unless they have all been subjected to like conditions. There is no evidence of the spread of contagion from sheep to sheep, and frequently only one foot is affected.

CONTAGIOUS FOOT-ROT.

Contagious or true foot-rot of sheep is quite a different form of disease to the foot-sore already described. In this country, where the flocks enjoy freedom from such veritable

plagues as foot-and-mouth disease and sheep-pox, true (contagious) foot-rot stands as one of the most serious diseases that exist among sheep generally, but it is a disease which is amenable to treatment, and can be prevented. If sheep-owners, therefore, appreciate the contagious nature of the disease and adopt effectual measures to prevent its introduction into a flock, or promptly combat it when introduced, they will be well repaid for their trouble.

Experiments have demonstrated the infective nature of the virus or poison of the disease by the application of the infected matter from diseased sheep to the feet of healthy sheep, and by the association of healthy sheep with diseased animals. The disease may affect sheep on dry or wet pastures if the infective agent be present.

It is admitted by those who are acquainted with the diseases affecting the feet of sheep that in some cases of foot-rot, especially in advanced cases, the diseased conditions may be so similar in appearance to foot-sore, that a differential diagnosis is very difficult; but by carefully considering all the circumstances, and by examining the fellow sheep, especially the more recent cases of disease, one will find that in foot-sore the trouble begins in the horn at the lower part of the foot.

Contagious foot-rot is primarily a disease affecting the soft structures of the foot. Any diseased condition of the horn itself is secondary, and is brought about by the separation of the soft from the horny structures through the agency of micro-organisms and the fluids exuded. The disease spreads from sheep to sheep, causing much lameness, loss of flesh, and even death from emaciation. If the disease appears in a flock of in-lamb ewes it is a still more serious matter, as proper treatment cannot be carried out without danger, owing to the pregnant condition of the ewes. In such instances the disease persists until the lambing season commences, and often spreads rapidly to the new-born lambs.

Apart from the adverse influence that wet seasons and damp low-lying pastures may have upon the horny structures of the feet, grit and dirt may work their way into the cleft of the foot and produce a wound. If the soil is contaminated with the virus that produces foot-rot, the disease will soon appear among the flock. It may, however, attack sheep with apparently firm horn and well trimmed feet.

Symptoms.

Lameness is usually the first symptom observed, and on examination of the affected foot a small, moist, unhealthy looking, spot-like sore will probably be found between the toes. The part is inflamed, hot and tender, and when it is manipulated the animal shows signs of pain. There is little or no appreciable swelling of the coronet at this stage. The

disease rapidly extends under the horny box, and if a little pressure be brought to bear on the inside of the foot a slight dirty fœtid discharge will be observed oozing from the edge of the horn around the ulcerated spot. The discharge is never very great, but is always foul smelling; in fact the fœtid smell is often detected before any gross lesions have been discovered.

The disease progresses from above downwards, between the sensitive structures of the horn and the hoof. When the horn is pared away the diseased parts are found bathed in the fœtid discharge, and the greater portion of the foot may be involved. In some cases the disease extends from the primary seat of the disease to the more important tissues of the foot, injuring the ligaments, tendons, and even the bones.

In protracted or severe cases the foot may be greatly swollen, very tender, and hot. The upper part of the toe is widely separated and the points turn inward, giving the appearance of a club. The animal is in great pain when weight is placed on the affected limb. Abscesses form in the soft tissues of the foot and burst outwardly around the coronet, leaving angry discharging wounds. One foot is usually affected at the outset, but the disease frequently appears in two, three, or even all four feet. In the latter case the animals are unable to move about in search of food. They may be seen feeding on their knees, or lying down feeding on the grass around them. In cases associated with much pain, and where three or four feet are affected, the animals refuse to feed, rapidly lose flesh, and may develop diarrhœa. Such animals become extremely weak. They present a dejected and emaciated appearance, and may die. The various stages of the disease can be seen in one flock. Granulating tissue or proud flesh and new horn-like tissue may grow out from the wounded surfaces. In the early stages of the disease the hoof itself appears normal, but as the condition advances the horn becomes broken and decayed, and if the feet have not been attended to, the whole toe may be cast. During hot weather the condition is aggravated, and deaths are more numerous from the fact that the fœtid discharge attracts flies, and maggots subsequently develop in the wounds. An affected animal may become fly-blown on every part of the fleece which has come in contact with the discharges, and under such conditions it soon succumbs.

Prevention.

It has been said that a shepherd has no right to have foot-rot among his flock. Providing ordinary care is observed the disease should at least not get beyond control. Although the best plan to prevent the introduction of the disease is to avoid bringing suspected sheep on to clean pastures, it is not one which can always be carried out. Attention must especially

be directed to fresh arrivals. In the first place it is necessary to examine any sheep which may fall lame, and any sheep which are not lame but are noticed to show wounds or sores around the hoof or over-grown horn.

1. Periodic inspection, examination and trimming of over-grown feet is a practice to be recommended, and upon the slightest indication of disease affecting the skin between the toes, the affected sheep should be isolated and treated, and the remainder put through a bath containing one of the preparations given below as cures for foot-rot.

2. In the case of sheep bought in a market, or taken to a market and brought back, or any fresh arrivals, they should whenever possible be isolated and the feet of each sheep examined. Isolation should be continued from three to four weeks, as disease might appear after an interval of two or three weeks, although the sheep appeared apparently free from disease at the time of arrival; or, as a precautionary measure after examination, the sheep should be put through one of the specially constructed shallow baths containing one of the preparations recommended below, on two or three occasions during the first week or ten days after arrival and before mixing with the other stock.

3. The shepherd should always wash and disinfect his hands after examination of the recently imported stock before attending to any of the old stock, and the same remarks apply after the examination of any individual suspected case.

4. It is advisable to afford contaminated pastures a rest from sheep until a winter's frost has intervened.

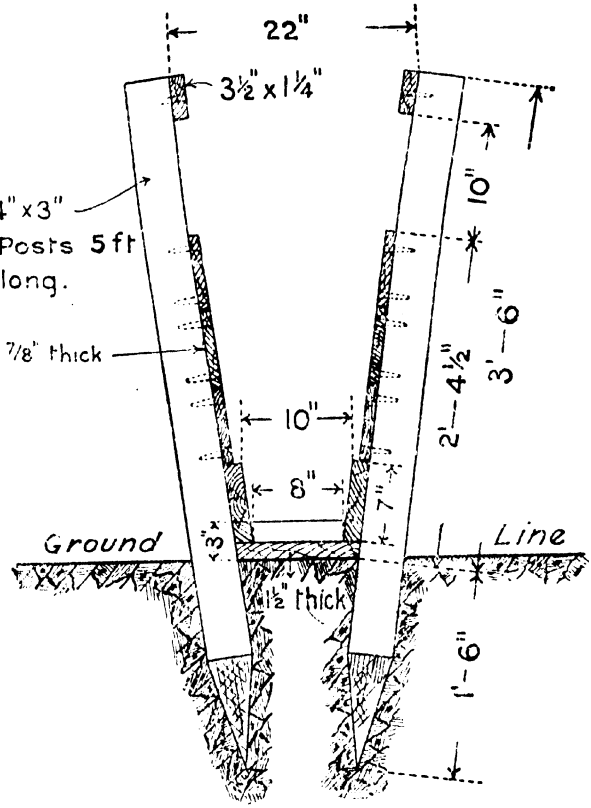
5. Attention must be given to the sheep fold and other pens, which should be thoroughly and effectually disinfected, and the manure and a few inches of the surface soil should be removed and ploughed into the land.

Remedy.

1. In the first place examination of the entire flock and separation of the healthy from the diseased animals should be carried out. The apparently healthy sheep should daily, or every second day, be put through a shallow bath or trough containing some suitable preparation, and the treatment may be advantageously continued for ten to fourteen days after the last case is detected.

2. It has been observed that a sheep may apparently recover from foot-rot without treatment, and the disease may break out again in the same sheep after an interval of several weeks. The second attack may be even worse than the first, but the animal may eventually recover without treatment, or it may die. Treatment, however, is necessary to avoid loss, and prompt measures will materially assist in arresting the spread of the disease to other members of the flock. The earlier the cases are recognised and treated, the more readily and certainly will they yield to treatment, and

aggravated and advanced cases—usually the result of neglect —should rarely occur. Everything possible should be done to prevent the disease extending into the deeper structures of



Foot-Rot Bath.—The bath, of which this is a vertical cross-section, may be made of wood or concrete, and should be about 16 ft. long. The width at the bottom should be 8 in., the sides about 7 in. high, sloping outwards, and if made of wood, boards about 1½ or 1¼ in. thick should be used. The ends should be 3 in. deep, or a little more than shown in the sketch, but deep enough to retain the solution while allowing the sheep to step over them easily. The bottom of the trough, if of wood, should have cross pieces nailed or screwed on at intervals of about a foot to prevent slipping. The floor of a concrete bath should be supplied with transverse grooves.

The sides above the trough should be nailed to posts 4 in. by 3 in. and 5 ft. long, driven firmly into the ground, 4 ft. apart. The run thus made should be wide enough to allow the sheep to walk freely through, and a width of 18 in. at 2 ft. from the ground will be found sufficient even for in-lamb ewes.

the foot, as these cannot be effectively treated without permanent damage to the foot. After thorough cleansing of the affected foot, all detached horn should be freely but carefully

removed, so as to expose the affected sensitive surfaces. Skill and patience must be exercised in paring away the horn of the foot, and the operation should not be carried out in the somewhat rough and careless manner that is adopted by some shepherds. It is imperative to expose all the diseased tissue, and the more advanced and neglected the case the greater will be the labour required. The exposed diseased parts should be thoroughly cleansed with suitable remedies by washing, or by standing the patient in a bath for several minutes. All granulations or fungoid growths should be removed with the knife or snipped off with scissors.

3. *It is important to remember that all removed particles* of horn or other tissue should be destroyed, buried or disinfected, as such material may serve as a means of further spreading the disease.

4. Whenever the cutting has been deep or the exposed surface is extensive, a piece of clean tow, previously saturated in some antiseptic solution, should be applied, and kept in position by a properly adjusted bandage.

5. Advanced and severe cases, implicating deep structures of the foot, will require more constant attention and repeated treatment, such as cutting away as much of the diseased tissue as possible at each inspection, cleansing and disinfecting, and finally covering the parts with antiseptic powder and bandaging to keep out both soil and filth. In the case of in-lamb ewes every care should be taken in handling the ewes, and when individual treatment is deferred until after lambing, all the flock should in the meanwhile be put through the shallow bath (mentioned below) in the ordinary way at frequent intervals.

The Use of the Foot-bath.

It was noticed some years ago that the ordinary process of dipping sheep had a curative effect on foot-rot, and the good results were ascribed to the action of the poison on the cause of the disease. Arguing from this it appeared probable to the Board of Agriculture and Fisheries that beneficial results would follow the walking of affected sheep through a solution of poison just deep enough to cover the hoof. In practice this was found to be the case.

In order to test the effects of such treatment on a considerable scale the Board, early in 1904, distributed 30 baths (16 feet by 1 foot), each accompanied by 1 cwt. of copper sulphate (bluestone), amongst a corresponding number of sheep farmers in Great Britain. The instructions were to walk the sheep once a month or oftener through a 5 per cent. solution of the copper sulphate (1 lb. in 2 gallons of water), after having cleaned and dressed the hoofs in the case of a bad attack.

Reports from most of the recipients were received, and they were quite unanimous in ascribing much benefit to

the use of the bath. It would appear, however, from the information to hand, that still better results (especially where it is a case of curing rather than preventing) will be got by using a 10 per cent. solution (1 lb. of copper sulphate to 1 gallon water), and, as stated above, the sheep should be put through the bath at frequent intervals.

Although the Board have only experimented with copper sulphate, they are aware that other substances are used, *e.g.*, 3 oz. arsenic, mixed with 3 oz. washing soda and boiled in 2 gallons of water; or 1 part of commercial sulphuric acid to 10 parts of water. Arsenical and other sheep-scab dips may also be used, but it is doubtful whether any substance is more effective than copper sulphate, which is comparatively safe and easy to use.

Summary of Directions for using the Foot-bath:—

a.—Bath of wood or concrete, 16 feet long and 8 inches wide (12 inches is unnecessarily wide), sides sloping out, ends 3 inches deep, provided with cross pieces or grooves to prevent slipping, side fences close boarded and to slope out so as to admit of the sheep walking easily through. (*See* Sketch, p. 6.)

b.—Solution to consist of 1 lb. copper sulphate in 1 gallon of water or, if prevention only is aimed at, half this strength will suffice. Time to be allowed for thorough solution.

c.—Copper sulphate to be bought under a guarantee of purity (98 per cent.), and if possible in the powdered state, not in large crystals.

d.—Sheep if badly affected to have their hoofs pared before being put through the bath.

e.—A day when the grass and soil are dry to be selected.

f.—Copper sulphate and most of the substances used being poisonous, a cover for the bath to prevent stock drinking the solution may be an advantage. In any case the bath must be well fenced in.

g.—If ewes with lambs at foot are treated, they should be put through very quietly so as to prevent the solution getting on to the teats, and thus into the mouths of the lambs.

h.—Sheep with long wool should also be put through very quietly, or otherwise the solution may, under certain circumstances, discolour the wool.

Whitehall Place, London, S.W.1,
September, 1905.
Revised, August, 1908.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Larch Canker (*Dasyscypha calycina*).*

This destructive parasite is present in greater or less quantity depending on local conditions, wherever the larch (*Larix europaea*) grows. In this country it also occurs on the Scots pine (*Pinus silvestris*), the silver fir (*Abies pectinata*), the Corsican pine (*Pinus Laricio*), the Swiss Stone pine (*P. cembra*), and the Japanese larch (*Larix leptolepis*).

The fungus is a wound-parasite; in other words, it cannot gain an entrance into the tissues of a living tree except through a wound. The wounds ordinarily occurring in nature through which infection takes place, may be grouped under five headings:—(1) Wounds caused by wind, or by snow resting on the branches; (2) cracks caused by late frosts; (3) gnawing of the bark by rodents; (4) numerous punctures made by the proboscides of the larch aphides (*Chermes laricis*), and possibly the nibbling of the bark by the fungus fairy fly, *Caecilius flavidus*†; and (5) wounds made near the base of the stem in planting.

The general appearance of the fungus, and the injury and resin-flow following its attack, are clearly shown in the accompanying illustration.

As a broad rule, it may be stated, that when trees under ten years of age are attacked by canker, they are either killed outright, or are so deformed that if they continue to grow, they are of very little value for timber. The reason is that in the case of seedlings or very young trees, the main stem is the part usually attacked, whereas in older trees the bark of the trunk becomes so rigid that it is impervious to the punctures of aphides or to injury by late frosts; and the only chance of infection is when branches are broken off, or more or less cracked at the point where they leave the trunk.

When a young tree is once attacked it very rarely recovers, as the mycelium spreads in the tissues and starts new wounds at some distance from the original point of infection.

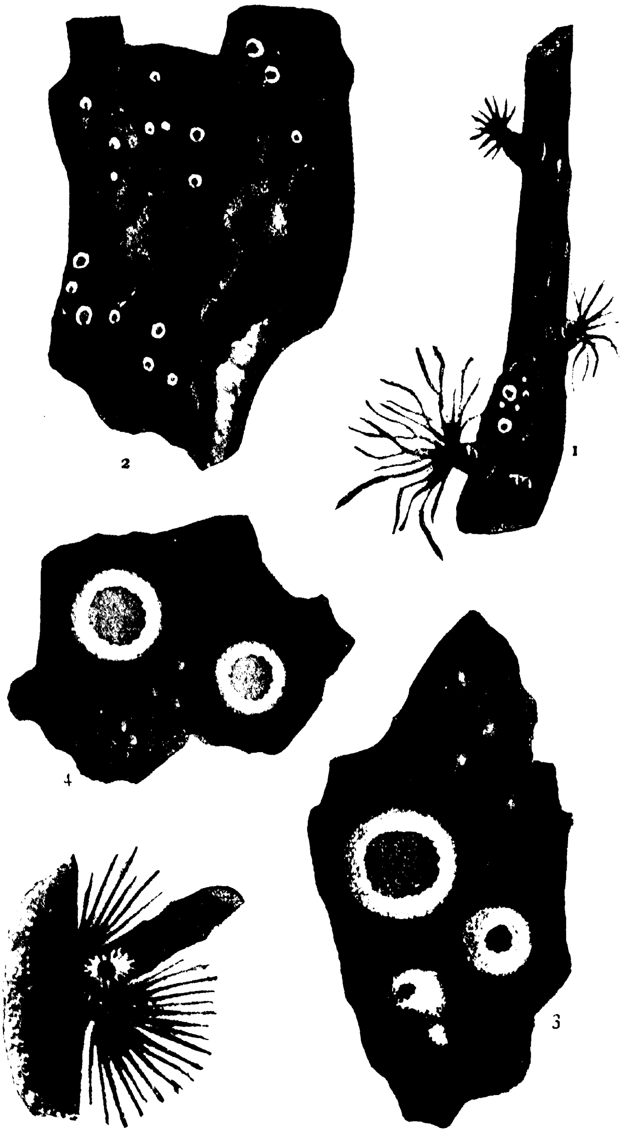
Methods of Prevention.

(1.) As a safeguard against inoculation taking place through fissures in the bark caused by late spring frosts, it is

* A more detailed account of this disease, illustrated by one coloured and two other plates, appeared in the Board's *Journal* for September, 1902.

† See *Journal* of the Board of Agriculture, December, 1907, p. 551.

Leaflet No 155.



LARCH AND SPRUCE CANKER.

advisable not to form seed-beds nor plant larch in low-lying damp positions, where not only are the plants most exposed to frost, but the conditions favour the presence of the aphis.

(2.) Perhaps the larch aphis* can best be combated by spraying during winter, or when the larch is in resting condition and has not burst its buds. Paraffin emulsion should be used, and the object is to destroy the hibernating aphides. A paraffin emulsion used successfully in winter against hibernating generation on the spruce was composed of 3 lb. of soft-soap dissolved in 2 quarts of boiling water ; while this was still boiling hot, 1 pint of paraffin was added and the whole thoroughly churned. This was diluted with 5 gallons of soft water before use.

For use against the larch aphis in spring and summer a dilute paraffin emulsion would be effective.

(3.) The rank growth of grass and weeds round young trees greatly favours the development and spread of canker, by keeping the trees constantly moist.

(4.) Trees that are badly diseased should be removed and burned.

(5.) Great care should be taken not to injure the bark of young plants when lifted from the nursery, or in planting, as is often done when the turf or soil is pressed firmly round the stem by the heel of the planter.

(6.) A practice which has been generally recommended is to mix the larches with some dense-crowned species (spruce, silver fir, Douglas fir, or beech), the intention being to surround each individual larch with other species immune to the disease. Should the parasite appear on any particular tree, the chances of the spores spreading to other trees of the same species would be reduced to a minimum. Although such a system has undoubtedly proved an advantage to the larch, it has not in all cases sufficed to protect this tree against disease.

(7.) A system which promises to provide a satisfactory solution of the difficulty has for some years been practised by Mr. Munro Ferguson, of Novar, in his extensive woods in Ross-shire. Pure larch woods are planted, and when the trees are 16 to 20 years old all are removed except the soundest and most promising, of which 300 to 500 are left per acre. These trees are the picked stems of the 3,000 or 4,000 originally occupying the ground, and measure up to 51 ft. in height and 4 ins. to 8 ins. in diameter at breast-height. Stems that are sound, or fairly sound, at this stage are not likely to suffer much from disease in later life.

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* The aphis on the larch is a stage in a life-cycle which begins on the spruce. This should be borne in mind in the treatment of aphis on the larch.

The thinning in such a system is done as early as possible in autumn or winter, and this is followed by knocking off all the lower dead branches of the trees that are retained. The "top and lop" of the felled larches, together with the dead branches cleared off the standing stems, are collected into small heaps and burned. Without loss of time the area is then stocked with an underwood of a shade-bearing species,—e.g. *Thuja gigantea*, hemlock spruce, Sitka spruce, silver fir, Norway spruce, beech, &c. (This system is described at length in the *Journal* of the Board of Agriculture for March, 1906.)

Description of the Figures.

1. Portion of stem of a young larch, showing a small canker-wound with the fungus. Nat. size.
2. A small but characteristic canker, with the fruiting fungus present. Nat. size.
3. The two forms of fruit of the canker-fungus. Enlarged.
4. *Dasyscypha resinaria;* a fungus, forming canker on the spruce fir.
5. Portion of a larch branch showing the white flocculent tuft with a central drop of sap, which is constantly to be found near a "foundress" aphis with eggs. Spores of the canker-fungus often germinate in these drops of sap produced by the aphis, and start a canker spot.

Whitehall Place, London, S.W.1,
October, 1905.
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BOARD OF AGRICULTURE AND FISHERIES.

Hedgerow Timber.

Species.

At the present time the bulk of the hedgerow timber south of the Trent consists of English and Wych elm, oak, and ash. Of these the first-named is the most frequent species from Warwickshire southwards, except in certain districts which are characterised by stiff, sour clays, or by very poor or high-lying land, such as the Downs or Wolds. On clay land, or in districts which have only been cleared of natural woodland within comparatively recent times, the oak and ash are usually plentiful, while the Wych elm is abundant in Essex. These last three species also form practically the whole of the ordinary hedgerow timber in the Midlands and North of England, while sycamore also becomes more plentiful towards the North. Where other species occur, such as beech, black Italian poplar, &c., it may be taken for granted that they have been planted.

Advantages and Disadvantages.

Taking English hedgerow trees as a whole, there are three fairly distinct points of view from which they may be judged: 1st, their value as an ornamental feature of the landscape; 2nd, their importance in providing shade and shelter from hot sun, or from cold or strong winds, for men, live stock, or crops; and, 3rd, their value as a source of timber.

The ornamental features of hedgerow trees depend almost entirely upon the suitability of the soil and situation for the species grown. Shapely and well-developed trees, whatever the species may be, cannot fail to improve the landscape and render an otherwise bare or uninteresting country more or less picturesque.

The importance of hedgerow timber in providing shade and shelter is difficult to estimate with any degree of accuracy. There can be little doubt, however, that hedgerow trees act as wind-breaks and diminish the evaporation of moisture from the surface of contiguous fields. A district thickly studded with such trees, therefore, should be warmer in winter and less affected by summer drought than one practically treeless. To the dairy farmer and stock breeder, therefore, hedgerow trees should, in general, be more beneficial than harmful, though the fact is not to be overlooked that sheep suffer more from foot-rot on pastures that are much shaded. To the arable farmer, hedgerow trees are rarely of much benefit, except in the

way of acting as general wind-breaks, for they cause the unequal ripening of crops by shading the ground, while their roots rob the soil in their neighbourhood and cause a reduced yield, and with fields of small acreage this may constitute a considerable loss.

Hedgerow timber in general is grown under two great disadvantages: 1st, height-growth and the formation of long straight boles are interfered with by prevailing winds, and by the absence of competition between individual trees; and, 2nd, the unrestricted development of side branches, tends to the production of coarse, knotty timber. These disadvantages are more or less common to all hedgerow trees, but they are very much greater with some species than with others. An ideal hedgerow tree may be said to be one which is little affected by the prevailing wind, retains its leading shoot until late in life when grown alone, and has no great tendency to develop large side branches near the ground. Such a species is not easy to find. Sycamore and ash stand wind well, and are not characterised by low side branches, but they are both apt to lose their leading shoot early in life and develop a short bole. Wych elm quickly loses its leading shoot, and forms a low spreading crown, and the same happens to the oak, except on a first-class oak soil, and there attention should be chiefly directed to this tree for hedgerow planting. Care should be taken to use only the sessile-flowered species, the branches of which are much less spreading than is the case with the pedunculate oak. The beech speedily kills any hedge plants over which it casts its shade, so that its use, in this connection, is practically excluded.

The English elm is probably the tree best suited for hedgerow planting over wide stretches in the Midlands and South of England. The value of the timber is not high, but taking into consideration its tall, straight, and well-shaped bole, its comparatively small crown, and the rapidity of its growth, one is certainly justified in regarding this tree as worth its standing room. An additional feature of value connected with the English elm consists in the fact that it propagates itself readily from suckers, so that a continuous succession of saplings is always coming on to take the place of felled or blown timber.

As regards soil, the same principle applies in a general way to this tree as to any other species, and poor soils are not likely to bring about satisfactory results, either in landscape effect or commercial timber. In the South of England, however, there are few soils which are not sufficiently deep and good to produce timber of fair size, though neither poor, hard gravels, nor stiff, wet clays are conducive to a rapid growth. Some of the best English elm timber is grown on the edge of the chalk districts, and in the

valleys which intersect the Downs. In most districts, however, at low or moderate elevations, trees containing 300 cubic ft. of timber are frequently met with, though butts averaging 80 ft. or 100 ft. make as good a price as any. The black Italian and silver poplars possess a high-pitched crown, and are thus well adapted to grow in a hedge. The lime and Spanish chestnut, on the other hand, cast too much shade to be altogether suitable.

Establishment.

Though much of the existing hedgerow timber may be considered as having originated spontaneously, and in the case of English elm or other sucker-producing trees may require no special measures for its reproduction, the establishment of hedgerow trees on fresh ground, or in a new hedge, can only be accomplished by planting. This should be done, if possible, at the time the hedge is planted, as smaller and less expensive plants can then be used. But where it is desired to plant in an old, or established hedge, stout well-rooted trees from 6–8 ft. high should be planted about 20 to 30 ft. apart, setting them securely in the centre of the hedge by cutting a trench through the latter, and filling in with some good fresh soil. Such trees must be protected from cattle and horses for a few years, and this is more easily done when the hedge is allowed to grow untrimmed for a time, so that those animals are prevented from reaching the stems of the trees by the long shoots of the hedge.

To obtain a park-like effect, arranging the trees both singly and in groups of twos or threes is a good plan, and by thinning out later on, modifications of the original idea can be brought about if desired. It is also as well to plant fairly thickly at the outset, as it is unlikely that every tree will develop into a good specimen, even when the most careful pruning is carried out.

Management.

The subsequent management will chiefly consist in the selection or retention of suitable trees or saplings and the removal of low side branches or double leaders at an early age. In selecting the saplings at each cutting or laying of the hedge only those with straight stems and well-defined leading shoots should be considered, all others being taken out whenever the opportunity occurs. Trees with crooked stems or of stunted growth, as well as any inclined to be flat-topped early in life, should be removed as soon as they exhibit these features, or at the first periodic fall of timber which takes place, and only the best type of tree encouraged or allowed to grow to maturity. As soon as individual trees have reached a height of 30 ft. or so the

pruning off of low side branches should begin, and be continued periodically until good boles are obtained, while all wide-spreading branches should be shortened back. How much of the stem may be denuded of branches will depend on species, age, and soil, but generally speaking the clear bole may be one-third to one-fourth of the height of the tree. The branches removed from the bole should be sawn or cut off neatly close to the main stem, and if more than 3 in. in diameter should be dressed with coal tar. If pruned early enough, the pole-saw or pruning chisel will usually do all that is necessary, and at little expense. Neglected until the branches are large, however, pruning becomes a costly operation and one tending to blemish the timber. Judicious pruning both improves the quality of the timber and allows sufficient light to reach the ground below to enable an ordinary hedge to be maintained in health and vigour. A good deal, however, depends on the soil and climate, a hedge being able to stand more shade where the soil and climate are good than under other circumstances.

The chief point about the treatment of hedges under trees is the method of cutting (*see also* Leaflet 147, Fences and Hedges). It will usually be found that when they are either allowed to grow rough for four or five years, and then cut hard back, or when cut and laid periodically, the hedges are maintained in better health and are more capable of resisting stock than when cut or trimmed annually. Annual cutting also prevents tillers and suckers from getting away, as they cannot readily be distinguished from hedge shoots, and are usually cut off. But cut as suggested above, both hedge and suckers have an equal chance, and one is not favoured at the expense of the other. Cutting the timber before it attains too great a size or age also aids in preserving the vigour of a hedge. From 80—120 years is quite old enough for elm timber when grown at a normal rate, and at that age it has not overshadowed a hedge long enough to affect its constitutional vitality, provided it has been treated on rational lines.

A word of caution must be uttered with regard to driving nails into or fixing wire to trees. It is a slovenly and objectionable practice, and greatly diminishes the value of the timber.

Whitehall Place, London, S.W.1,
November, 1905.

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Leaflet No. 157.

BOARD OF AGRICULTURE AND FISHERIES.

The Sale of Newly-Hatched Chickens.

The sale of newly-hatched chickens, or, as they are frequently termed, "day-old" chickens, is a branch of the poultry industry which is now of considerable importance. Twenty years ago it was almost unknown in this country, but the introduction of incubators and brooders has made it possible to meet the growing demand for chickens. Large and profitable businesses have been built up and in some cases many thousands of chickens are sold annually. The first consideration is the number of incubators required, as these involve considerable expenditure.

Obtaining the Eggs.

A regular supply of fertile eggs will be necessary from January to June in order to keep the incubators filled, which requires a flock of fowls or an organisation for securing reliable supplies. For a plant with a capacity equal to the production of, say, 1,000 chickens per week from February to June, or twenty weeks in all, at least 30,000 eggs will be required. Assuming an average of sixty eggs produced by each hen during that time, 600 head of stock would be needed to meet the demand. The prime necessity is for the breeding stock to be vigorous and hardy and they should be kept, therefore, on a free, open range. Eggs from hens highly bred, highly fed, or kept in confinement are found not to hatch so well artificially as those produced from breeding stock treated in a more natural manner, while the chickens produced from such eggs are less vigorous and do not travel well. A free range for the stock may, indeed, be regarded as essential.

Pure or Cross-Bred Birds.

For the attainment of success it is necessary to be able to supply chickens of the breeds required by purchasers, and the demand varies in different districts. Eggs from cross-bred birds frequently hatch out a larger percentage, and

the chickens are hardier and travel better than some of the pure-breds, but the prices obtained for crosses are never so high as those for pure-bred chickens, while the cost of incubation and packing in each case is the same. For these reasons the trade is chiefly in definite breeds. Where operations are upon a smaller scale one breed only need be kept, provided an adequate demand can be secured. But in large establishments several breeds must be maintained, and these of the classes most saleable. Chicks of the heavier breeds are believed to stand travelling better than those of the lighter varieties.

Cost of Hatching and Prices obtained.

Experiments conducted upon the Reading College Poultry Farm, Theale, during 1904 and 1905, showed that, assuming the cost per egg to be one penny, and allowing for 30 per cent. of fertile eggs not hatching, but without charging anything for interest upon capital or for labour, the actual expense of producing a chicken was approximately 1¾*d.* Calculating interest and labour at the same figure, though this would be increased or decreased according to the extent of the operations, the prime cost may be reckoned at 3*s.* 6*d.* per dozen chickens at the time of hatching. To that must be added the expense of a suitable box for packing the birds and of conveyance to the nearest station, so that the actual cost may be stated as 4*s.* per dozen.

Prices vary considerably in accordance with the time of year and the class of fowls. Chickens, for instance, which are intended to be used as breeding stock command higher rates than those intended for killing or for farmyard purposes. But there is at present very little demand except for birds which are intended to be raised as breeding or laying stock. The popular varieties are largely in demand. Up to the present amateurs and smaller poultry-keepers have been the principal buyers.

The trade in selling day-old chicks to farmers is as yet in its infancy, as they have not fully realised the advantages of obtaining fresh stock in this way.

When to Despatch.

The best age at which to despatch the chickens is when they are twenty-four hours old, or as soon as they have dried off and overcome the strain of hatching. If sent away too early they would feel the change and be liable to take a chill, which would be fatal. When chicks are hatched either by the hen or by the machine, it is generally better to leave them in the place of hatching for twenty-four to thirty hours before removal to coop or brooder, and the same is largely true when they are to be sent away. But their despatch must not be too long delayed, for when once

they begin to eat, the supply of food must be regular. Chicks one day old travel better than older ones. Every additional day renders them more liable to feel the effects of transportation. When sent off at the right age, in suitable boxes, they will travel long distances by land or sea quite safely, even when the journey occupies as much as thirty-six hours.

Packing and Despatching.

The packages largely used are light wooden boxes, with several ventilating holes near the top of the sides and in the lid, and fitted with a handle made of thick cord, or tied round with thick string. Another useful form of box is made of cardboard with double sides to conserve the warmth and to provide ventilation without danger of chills. For a dozen chickens a box about 14 in. by 9 in. and 9 in. high is large enough ; for two dozen, 15 in. square. The floor should be thickly covered with cut chaff, among which may be scattered some coarse oatmeal, *dari*, and canary seed, and the sides, more especially the corners, lined with soft hay. The lid is better if lined either with cotton wool or with coarse flannel tacked at the edges, but loose enough to hang down in the centre. The box should be well made, and tied down, not nailed. There is much greater risk during very severe weather, more especially in cross-country journeys, when there is danger of exposure at open stations, and care should be taken to despatch the chicks by fast trains making good connections, and if possible at night. The sale of these birds takes place generally in the milder spring months, when the risk is not so great as it would be earlier in the season. Boxes should be prominently marked "Live chickens—this side up."

Treatment at Destination.

Not the least important point is the treatment of the chickens on arrival at their destination. It is to the vendor's interest to satisfy his customers by sending them hardy birds, but he has no means of controlling them when once they have left his charge, and the responsibility rests with the purchaser. There is nothing better than placing the chickens for an hour or two in a brooder heated to as near 100 degs. F. as possible, and in the absence of such an appliance, excellent results have been obtained by putting them, in a flannel-lined basket, into an oven (leaving the door open) at a temperature not higher than that named; or it will be enough if the basket is placed near the kitchen fire. They should then be given a good feed of warm steeped oatmeal or biscuit meal, and have a little warm milk to drink. If broody hens are available, the best results will be

obtained by rearing the chickens under them, if they have travelled a considerable distance. One or two only should be given to a hen at first and if she takes kindly to these the remainder may be slipped under her wings. Where rearers are to be employed (and small, inexpensive appliances are now sold), these must be well warmed up, say to 100 degrees F., and the chicks placed therein. The temperature should be reduced to 95 degrees or even 90 degrees in a couple of hours. Around or in these brooders, according to the class, cut chaff should be littered, and among it scattered what is known as dry feed.* In an hour or two the chicks will begin to scratch and seek for food.

Turkey Chicks.

The same system may be adopted for the sale of day-old Turkey chicks, a branch of poultry-keeping which is capable of great development, especially by farmers. Turkeys do not respond to artificial hatching and rearing, and they should be sent in a good roomy hamper, in which a nest is made, with the hen that hatched them. The mother should have a good feed before starting on the journey.

* *See* Leaflet No. 114 (*Feeding of Poultry*).

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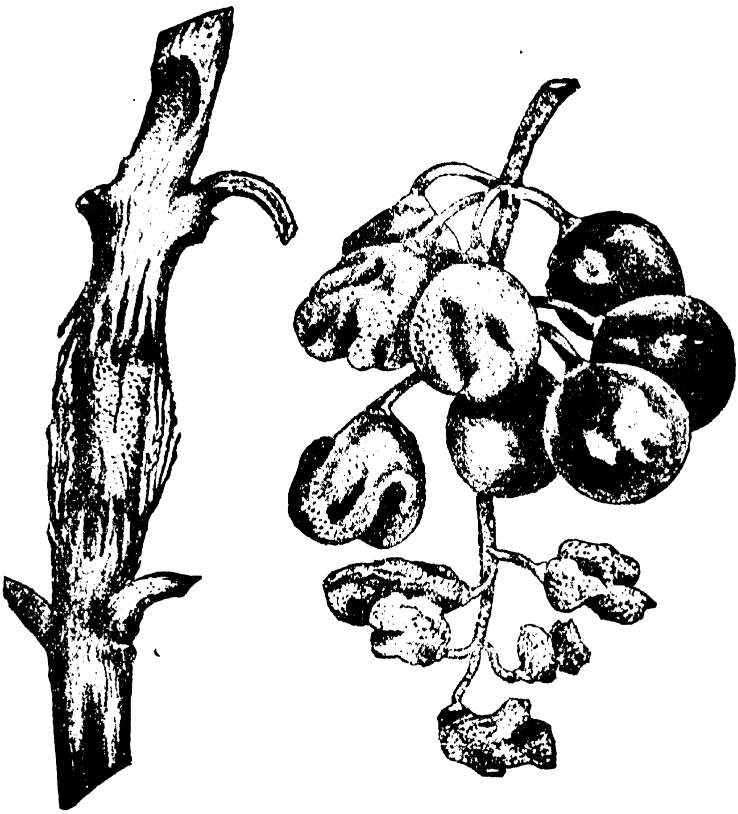
Leaflet No. 158.

BOARD OF AGRICULTURE AND FISHERIES.

White Rot of the Vine
(*Coniothyrium diplodiella*, Sacc.).



Grapes and Branch attacked by "White Rot."

This disease is due to the presence of a minute parasitic fungus. On the Continent and in the United States it attacks vines growing in the open air, and during recent years has frequently been met with on vines growing under glass in this country.

Parts of the Vine attacked.

The fruit is the part most frequently attacked. and in severe cases the fungus spreads from the stalk of the bunch of fruit to the branch from which it springs. The foliage is never attacked. When once established, the disease spreads rapidly, and usually every grape on a bunch becomes

diseased, owing to the numerous minute spores of the fungus being conveyed by rain, syringing, &c., from diseased to healthy berries.

Appearance of Infested Parts.

During the first stage of disease the berries become pale brown in colour, and soon commence to shrivel, but do not fall. At a later stage, when the shrivelled berries have become dry, the skin assumes a dull, silvery appearance, and is covered with minute white pimples forming the fruit of the fungus.

When the stalk of a diseased bunch is attacked, the fungus often extends to the supporting branch, where it forms slightly depressed areas, which are at first brownish in colour, but eventually become studded with the characteristic whitish pustules of the fungous fruit. The diseased patches may extend for several inches down one side, or the branch may be completely girdled by an irregular zone of diseased tissue, and, if this is the case, that portion of the branch above the injured zone soon dies. In vineyards the disease is most injurious during seasons of great humidity accompanied by warmth. Under such conditions one-quarter to one-third of the crop may be destroyed within the space of a few hours.

Remedies.

1.—The best remedy is to remove and burn all diseased bunches of fruit, and spray every part thoroughly once every five days with a rose-red solution of permanganate of potash. If the disease is of recent origin and confined to the bunches of fruit, the above treatment will suffice.

2.—If the disease has spread to the branches, its presence will be indicated by the slightly depressed, pale-coloured patches on the bark already mentioned. All such diseased branches should be cut out, as spraying will not check the disease on permanent parts of the vine, where the mycelium of the fungus spreads rapidly in the tissues.

3.—Where the disease has existed, every part of the vines, and the soil, walls, glass, &c., should be thoroughly drenched with a solution consisting of one pound of sulphate of copper dissolved in twenty-five gallons of water. This dressing should be applied during the winter before the leaf-buds begin to swell, otherwise the foliage will be destroyed.

Whitehall Place, London, S.W.1,
November, 1905.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 159.

BOARD OF AGRICULTURE AND FISHERIES.

Blindness in Barley and Oats.

Since 1897 attention has been drawn in Great Britain to a disease of the barley crop known as "blindness" or barley "stripe."

Plants attacked.

Fifty years ago, Rabenhorst, a German botanist, issued specimens of a minute fungus under the name of *Helminthosporium gramineum*, parasitic on the leaves of cultivated barley in Germany. It was noted that plants attacked by the fungus died during the flowering period.

The fungus has subsequently been recorded from other European countries as a parasite on barley, and has in many cases caused serious losses. It does not, however, appear in any instance to have assumed the proportions of an extended epidemic, but has been local and sporadic in its occurrence. During recent years the disease has become common in this country, and in some districts it is now difficult to find a barley field free from it. It is not unusual to find some twenty per cent. of the plants killed by the attacks of this fungus.

The fungus has also been observed on the leaves of wild barley (*Hordeum murinum*) in the neighbourhood of Kew.

Ravn, a Danish botanist, has recently studied the disease, and has shown that oats are subject to a similar disease, caused by a fungus very closely allied to the *Helminthosporium* of barley.

Appearance of attacked Crop.

The symptoms are characteristic and not likely to be confused with those of other disease to which the barley crop is liable. The foliage of the diseased plant, even in the seedling stage, is marked with olive-brown or purple-brown stripes and flecks. The infected plant may wither and die at this stage, but more often it appears that death does not take place until the flowering stage is reached. Then, just as the ears are pushing through the sheaths, the plant turns brown and dies off completely. Unaffected plants quickly grow above those which have become infected and consequently the presence of the disease is not readily detected unless a special search is made for it. Whilst the crop is being thrashed the blind ears of diseased plants are conspicuous amongst the straw, and often give the first indication of the losses the parasite has caused.

Methods of Prevention.

1.—The fungus is not difficult to deal with in practice. The evidence points to the fact that the death of the plant is due to infection at a very early stage of its development with spores of the fungus lurking on the grain coats. The application of any method which will destroy such spores should naturally result in a disease-free crop. Working on this assumption numbers of preventive measures have been tried, and among these may be mentioned steeping the grain before sowing either (1) in a solution of copper sulphate, or (2) in dilute formalin, or (3) in water at a temperature of 132 deg. F.

2.—Each of the foregoing methods has proved more or less satisfactory, but the best results have been secured by the use of dilute formalin. The most effective method of employing this is to make up a solution of one part of formalin in 160 of water (1 pint of the formalin in 20 gallons of water). The grain should be placed in a sack or wicker basket and steeped in the formalin solution for about five minutes, care being taken to moisten it thoroughly by lifting the sack or basket from time to time and twisting it about in the solution. Further quantities of grain may be treated with the same solution. In place of steeping in a basket a heap of grain may be sprinkled with the dilute formalin and turned repeatedly to distribute the solution thoroughly.

The cost per bushel of seed grain treated is very small, formalin costing 1*s*. 6*d*. to 2*s*. per pint, this amount, in 20 gallons of water, being sufficient for steeping about 30 bushels of seed. As the method also destroys the spores of barley smut it can be relied upon to pay for itself. In a series of experiments recently carried out the application of formalin resulted in an increase of over twenty per cent. in the crop.

Whitehall Place, London, S.W.1,
November, 1905.

Revised, July, 1908.

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BOARD OF AGRICULTURE AND FISHERIES.

The Cultivation of Lucerne (*Medicago sativa*).

Lucerne or Alfalfa, as a forage crop, was known to the ancient Greeks, Romans and Persians, and at the present day it is extensively grown in many parts of Europe and Asia as well as in the United States of America, in Canada, and in Argentina. In all of these countries it is regarded as one of the most productive and most nutritive of crops for the provision either of green forage or of hay. In Great Britain its cultivation is confined chiefly to the South Eastern Counties, notably Essex, Kent and Suffolk. Smaller areas, however, occur throughout practically the whole of England; and it may be found in Scotland in isolated patches as far north as Caithness. The area under Lucerne in this country is insignificant in comparison with the value of the crop, and it is possible that were its successful cultivation more generally understood, it would be much more widely grown.

Character of the Plant.

Lucerne is a perennial with a very extensive and deep root system. Where the subsoil is sufficiently open the roots will descend many feet, and thus draw upon water and food material which are beyond the reach of most farm plants. It is therefore particularly adapted to hot, dry climates, where the more shallow-rooted plants would fail to establish themselves. From the thick root-stock arises a number of erect stems reaching a height of from one to two feet, and furnished with an abundance of alternate leaves having three leaflets; flowers, generally purple in colour, and of the type of the vetch family, are produced in the angle between the stem and leaf stalk. Lucerne does not reach its full development in this country till about the third season.

Its Value to the Farmer.

It has two distinct uses on the farm. It may be included as a constituent of a "seeds" mixture for both temporary and permanent pasture and for hay, or it may be grown alone as a forage crop, fed green or made into hay.

It is a highly nutritious food, being specially rich in protein, and it is much relished by all classes of stock. It is specially suitable for feeding to horses and milking cows, and to the latter it may be fed as a perfectly good substitute for the mixture of vetches and oats so much in favour with dairy farmers in late summer and autumn. It also forms excellent

forage for pigs, and might be grown more frequently in orchards or fruit plantations in strips between the rows of trees. It could either be fed off with pigs or ploughed in as green manure. Under favourable conditions it produces an enormous yield of fodder, furnishing annually from two to five cuttings, aggregating up to 20 tons or more, of green forage per acre. When grown for hay, from two to four tons per acre represents a good crop. Its permanent character and its deep rooting habit are also greatly in its favour. Under suitable conditions a "stand" may last from five to ten years in this country, and when it has to be ploughed up the soil will have become enriched with a large amount of highly nitrogenous root residue.

Soil and Climate.

Lucerne undoubtedly thrives best in dry and warm climates and where the soil is well drained, not too heavy in texture and is well supplied with lime. Where, however, the crop fails it must not be too readily assumed that climatic conditions are unsuitable or that failure is due to lack of lime or the defective physical condition of the soil. Like other leguminous plants its healthy growth depends largely on the presence in the soil of the requisite nitrogen-collecting organism, which flourishes in its root nodules, and in districts where lucerne has not been previously grown the specific organism, although, in all probability, present in the soil, may not be there in sufficient numbers or activity materially to affect the growth of the plant.

The presence of the lucerne plant in the soil, however, seems to induce a rapid multiplication of the special organisms found in the nodules, and if the plant can be kept going during the first year or two by a dressing of soluble nitrogenous artificial manure, it will gradually become independent of extraneous supplies of nitrogen. Perhaps a cheaper and more efficacious way of supplying nitrogen is to inoculate the soil with the special organism. This may be done either by means of a pure culture or by obtaining soil from a district where lucerne is known to flourish. A small quantity of such soil distributed broad-cast over the field and harrowed in, has frequently been the means of establishing a plant of lucerne where the successful cultivation of the crop had hitherto been considered impossible.

Preparing the Seed-bed.

One of the chief difficulties in connection with the growing of Lucerne in a comparatively moist climate like that of the British Isles, is the tendency of grassy weeds to spread over the ground and smother out the plant. It is particularly necessary, therefore, that the soil be thoroughly cleaned

before sowing and the cultivation of a kind that induces rapid growth. It is generally advisable to take Lucerne after a fallow crop, such as potatoes, or roots, that has been well manured and kept thoroughly free from weeds.

Seed and Method of Sowing.

There are no well-marked differences of form or type between the varieties of Lucerne grown, but their relative productivity in this country varies to some extent according to the environment to which they have been accustomed. The best European seed is produced in Provence (France); Canada, also, is a suitable source for seed, and, recently, a vigorous variety has been obtained from China. Great care should be taken to obtain good sound seed free from dodder. The seed may be sown either alone or with a corn crop. The former method is generally to be preferred, but when a nurse crop is considered desirable or when Lucerne is intended to form part of a grass mixture, the cover crop should be an open-growing one such as barley or wheat. The best time for sowing is between the middle of April and the end of May. When the crop is grown alone, from 20 to 30 lb. of seed are sown per acre, the quantity being least when the land is clean and in fine tilth. About 5 lb. less seed is required when drilled than when sown broad-cast; drills are placed from 8 to 10 inches apart. If the land is thoroughly clean, the seed may be sown broadcast; by this means the surface of the ground is more quickly covered by the crop and weeds are effectively excluded. As a rule, however, the best results are obtained by drilling, if the spaces between the rows are kept free from weeds.

Under the best conditions, however, Lucerne alone does not form a close bottom, and is apt, in a few years, to get overgrown with weeds. To prevent this, suitable grasses are sometimes broad-cast along with Lucerne; such grasses as Cocksfoot, Timothy and Meadow Fescue, all of which are tall and open in their habit of growth, may be recommended, as being less likely to smother the Lucerne plants than grasses of a close and creeping habit of growth. For the production of hay the following mixture may be tried: 25 lb. Lucerne, 5 lb. Cocksfoot or Timothy, 7 lb. Meadow Fescue.

About 2 lb. Lucerne seed per acre may be included in the ordinary mixtures of grasses and clovers for pasturage.

Manuring.

The application of suitable manures in addition to increasing the yield tends to prolong the life of the plant. No hard or fast rules, however, can be laid down as to the best manures to use, for with Lucerne, more so than with

most other plants, much depends on the character of the soil and climate. Generally speaking, however, phosphatic and potassic manures are most required. On clay soils about 2 or 3 cwts. of superphosphate per acre may be a sufficient annual dressing. On light soils potash in addition—say ¾ cwt. sulphate or muriate of potash—may prove profitable, and where Lucerne has not been grown previously, and there is reason to believe that the requisite nitrogen-collecting organism is not sufficiently active, a nitrogenous manure, say ¾ cwt. nitrate of soda, might also be useful. Farmyard manure is not to be recommended generally for direct application to the crop, but it may be used fairly liberally on the preceding fallow crop. On soils not naturally rich in lime 10–20 cwt. ground lime should be applied before sowing, or 2–3 tons per acre of shell lime may be used for a preparatory crop.

Cutting and Using the Crop.

When made into hay Lucerne is frequently cut twice. Cutting should take place just before the flowers open, as, when left till later, the plant becomes fibrous and more difficult of digestion. Early cutting also induces a better aftermath and a more leafy crop. In making Lucerne hay all operations should be directed towards the preservation of the leaves which are very liable to break off if dried too quickly. No more should be cut in one day than can be conveniently dealt with in a short time. The crop must not be left to become scorched while in the swath; but after partial drying it should be gradually cured in cocks.

When used as green fodder it should be cut fairly young and before the flowering stage is reached. It should be fed sparingly at first, and not in a wet condition, otherwise it is apt to cause "hoven" in cattle and sheep.

Whitehall Place, London, S.W.1,
April, 1906.
Revised, October, 1915.

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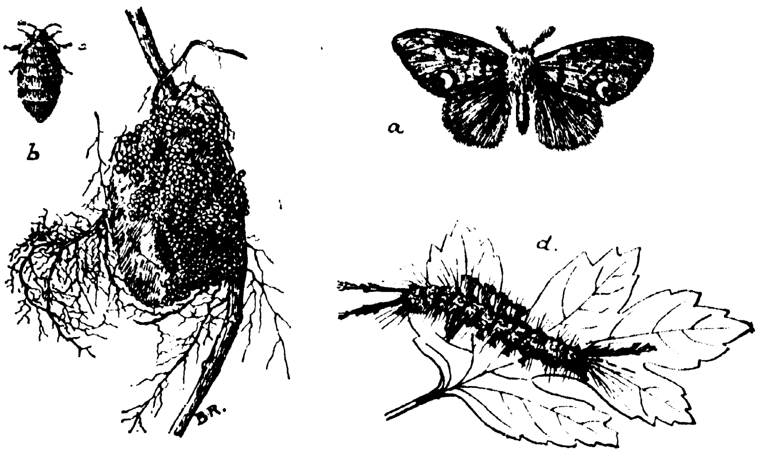
Leaflet No. 161.

BOARD OF AGRICULTURE AND FISHERIES.

The Vapourer Moth (*Orgyia antiqua*).



VAPOURER MOTH : *a.* Male ; *b.* Female ; *c.* Cocoon, surrounded by eggs ; *d.* Caterpillar.

The caterpillars of this moth are harmful to forest trees, fruit trees, garden plants, and even to pot plants, and in some seasons are very destructive. The food plants are very numerous, and include pear, plum, apricot, sloe, hawthorn, apple, strawberry, mountain ash, rose, bilberry, laurel, mahonia, elm, willow, poplar, birch, alder, hazel, hornbeam, beech, oak, ash, lime, while there are records of severe infestation on pine and spruce. The caterpillars may be found from May to September, and the adult moths may be taken any time from the middle of July up to and including October. The Vapourer Moth is found in Europe, N. Africa, and Western Asia. It is common throughout Great Britain and Ireland and is to be found in towns as well as in the country.

Description of the Insect.

Moth.—There is a marked difference between the male and female moths. The *male (Fig. a.) measures from 1 inch* to 1¼ inch in expanse of wings. The body is brown: the wings are ochreous or chestnut brown, the fore-wings having dark markings. Near the hind angle of each fore-wing is a somewhat crescent-shaped clear white spot. The antennæ are double-combed. The *female* (Fig. *b.*) is yellow-grey in colour, hairy, and unable to fly, the wings being reduced to mere stumps. The antennæ are saw-like or single combed.

Egg.—The eggs (Fig. *c.*) are whitish-grey in colour and are laid in great numbers. Examined with a lens they are seen to be round, but somewhat flattened on the upper side.

Caterpillar.—The caterpillar (Fig. *d.*) presents a very gay appearance. It is very hairy, long light-coloured hairs springing from reddish warts all down each side of the body. Tufts of yellow or brownish hairs are very conspicuous on the back of the 1st, 2nd, 3rd, and 4th abdominal segments, two tufts to each segment. Conspicuous also are two dark-coloured tufts arising from the 1st thoracic segment (*i.e.*, the first ring behind the head) pointing forward on each side of the head, and at the tail end is a tuft of black feather-like hairs. From each side of the 1st thoracic segment and the 2nd abdominal segment (*i.e.*, rings one and five behind the head) a dark tuft projects. The under side of the caterpillar is yellowish. The full grown caterpillar measures about one inch.

Pupa.—The chrysalis is dark brown and lies under cover of a somewhat oval-shaped yellow-grey web or cocoon (Fig. *c.*). Mixed in the web are the hairs of the caterpillar.

Life History.

The male moths fly actively, but the females are very sluggish. On issuing from the pupa the female settles on the outside of the cocoon, and, after pairing, lays, on and all round the cocoon, eggs up to 300 or more. Some of these eggs hatch in a fortnight to three weeks, while others laid at the same time may not produce caterpillars until the following spring. From this it follows that all stages of the insect from egg to adult may be met with at the same time. Soon after hatching the young caterpillars scatter over the tree. When they are full fed they spin cocoons, which are attached to leaves, twigs, bark, or to a neighbouring post or fence. The moths emerge from the pupæ in about three weeks. Two broods in the year are

possible. If the eggs that have passed through the winter hatch in the early part of May, the resulting caterpillars may become adult in time to allow for a second brood of moths by October. On the other hand there may be only one generation in the year, in which case the eggs laid by the first brood pass through the autumn and winter and hatch the following spring. Weather conditions have great influence on the production of second broods, which are usually most numerous in a hot summer. Owing to the irregularity in the hatching of the eggs and the varying extent to which a second brood is produced, there is considerable overlapping between the successive generations and larvæ may be found throughout the whole summer and early autumn.

Methods of Control.

1. The cocoons covered with eggs should be destroyed during the winter.
2. The larvæ are conspicuous and may be picked or shaken off garden plants, if spraying is not desirable.
3. Attacked plants may be sprayed with lead arsenate or with one of the various vegetable poisons now on the market.
4. The females are wingless and move very little. The species, therefore, can only spread when in the larval stage and, if care is taken in dealing with the first attack, the insect is not difficult to control.

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May, 1906.

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Leaflet No. 162.

BOARD OF AGRICULTURE AND FISHERIES.

Grafting Fruit Trees.

Grafting or budding, though requiring some skill, is not a difficult art to learn. The best way is to obtain some practical instruction, and then, before attempting anything with growing stocks, to practise the various cuts and fittings with pieces of wood of different sizes.

To attain success in grafting the worker must employ stocks which are in just the right condition, *i.e.*, with the sap flowing freely, the grafts nicely fresh and not shrivelled, and all cuts made cleanly and fitting together exactly. It can be easily ascertained if the sap is right in the stock by cutting off the latter some little distance above the point where the graft is to be placed, making a slit in the bark and observing if it parts freely from the wood. If it will not part freely the grafts would not be likely to "take" and the operation must be postponed. It is customary to remove the grafts (scions) from the trees during January and February according to the district. After cutting, they may be neatly tied in bundles with the ends level, carefully labelled, with the name showing, and stood in deepish drills in a shaded border, with the soil made firm round the ends. They may also be kept fresh for some time by standing them in a couple of inches of water in a dish in a cool room. To make the cuts clean a very sharp knife must be used, and the smoother the cuts are made, the more quickly they heal.

The time for grafting various fruits depends very much on the earliness or otherwise of the season. The most suitable time for plums, apples and pears, is from the second week in March to the end of April. When it is not possible to undertake the operation during this period it may be carried out in May.

Preparation and Planting of Stocks.

It is generally better to purchase stocks from firms who make a speciality of them and supply the trade, than to attempt to raise them. They are very cheap—not more than thirty-five shillings per thousand if bought in quantity. If only a few dozens or scores are wanted, it is as well to obtain them from the nearest reliable nurseryman. The soil for stocks should be deeply cultivated and in good condition; soil suitable for the production of a good crop of potatoes or cabbage will be suitable for nursery "stocks." No manure should be applied where it would be under the roots, as it encourages downward rooting. The soil should be ready by the time the stocks can be obtained in early winter. When received, it is well to sort the stocks according to size,

trim the roots, and shorten the heads to about two feet in length. They may then be placed with the roots in soil, to keep fresh till they can be planted.

Stocks should be planted in rows three feet apart, and one foot apart in the rows, at the same depth as they had been previously. The roots may be covered with a little soil and then manure applied to encourage lateral and surface rooting. After treading very firmly, keeping the lines quite straight, the soil may be lightly forked over just to loosen the surface. When sorting over, all stocks should be carefully examined for American blight, and, if any is found, dressed accordingly. (*See* Leaflet No. 34.) In the summer, they must be examined for aphides, and, if any are found, sprayed with a soft soap wash. (*See* Leaflet No. 104.)

If the stocks do well, they should be ready for budding in August and September following, or grafting in the spring of the next year. The smaller ones may need another year's growth.

Kinds of Stocks.

For *apples* to be grown as standards, half-standards, or espaliers, the seedling apple and seedling crab are to be recommended, and for dwarf or bush trees, the English Paradise stock; for *pears*, the seedling pear and quince respectively. *Plums* are usually budded and grafted on the seedling plum and Myrobalan plum. With many growers, however, the Myrobalan stock has become unpopular, and the Pershore or Egg plum stock is now often used in its place. *Apricots* are worked on the Myrobalan or on the Mussel and Brussels plums. For *cherries*, the Mahaleb and wild cherry are used, while for *peaches* and *nectarines*, the almond and plum are employed. A batch of stocks can readily be raised by taking up suckers from various trees, but it is a bad practice, as they are prone to future suckering.

All stone fruits do better when budded than when grafted, there being a truer junction between bud and stock than obtains with grafts, and the bulk of nursery stocks of apples and pears are also budded.

Methods of Grafting.

Whip or Tongue Grafting.—This method (Fig. 1) is chiefly employed in the case of stocks of about half an inch to an inch in diameter. The graft is prepared by taking off a slice on one side about 1½ to 2 in. long, the upper end of the cut being opposite a bud, and the lower end cut away to nothing. The stock should have been cut off about 4 to 6 in. from the soil. Place the graft against the stock to measure how long to make the cut on the latter, then shave off a slice of bark and wood just a little wider than the cut on the graft. This is necessary in order to make the two *inner* barks of graft and stock fit together, and the bark of the former would be thinner than that of the latter. It is between the inner bark

and the wood that the union or junction is formed. The tongues in both must then be fitted together as shown and tied securely with bast or raffia and waxed over. Sometimes another small tongue is made in the stock at the bottom of the cut and the end of the graft tucked under it, as shown in Fig. 1, E, *n*.

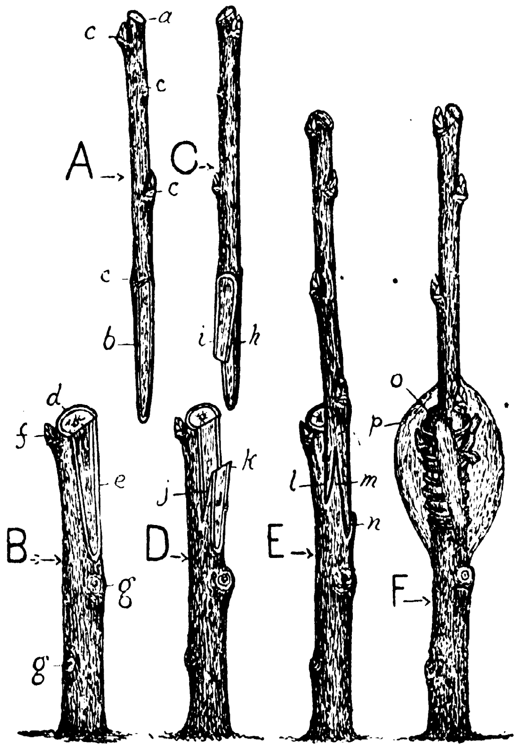

FIG. 1.—WHIP OR TONGUE GRAFTING.

A, scion or graft partly prepared : *a*, upper end cut sloping from a bud ; *b*, lower end sliced ; *c*, position of buds. B, stock partly prepared : *d*, point of severing top of stock ; *e*, sliced for fitting of graft ; *f*, bud left (if present) to attract sap ; *g*, points where growths removed. C, graft tongued : *h*, opening ; *i*, tongue. D, stock tongued : *j*, opening ; *k*, tongue. E, graft fitted properly on stock : *l*, tongue of graft ; *m*, tongue of stock ; *n*, small tongue (sometimes made and end of graft inserted in it). F, graft and stock tied and *o*, waxed ; or *p*, clayed.

Saddle Grafting.—There are various methods of saddle grafting The first (Fig. 2) may be used in grafting stocks about three-quarters of an inch to an inch and a half in diameter. This stock is made to an acute wedge shape by cutting off a slice on each side. Another (downward) cut on each side is made through the bark and a thin slice of the wood. The graft is cut saddle-shaped as shown by making a

cut on each side of the same length—about $1\frac{1}{2}$ to 2 in. Both cuts are rather thin till they reach the upper end opposite to a bud, when the knife is slipped in, and, when the second cut is made, the piece of wood drops out. The graft may now be placed in position across the wedged end of the stock, allowing the ends to go underneath the bark; then tied in and waxed. Grafts made in this way take very well and soon grow over the stocks

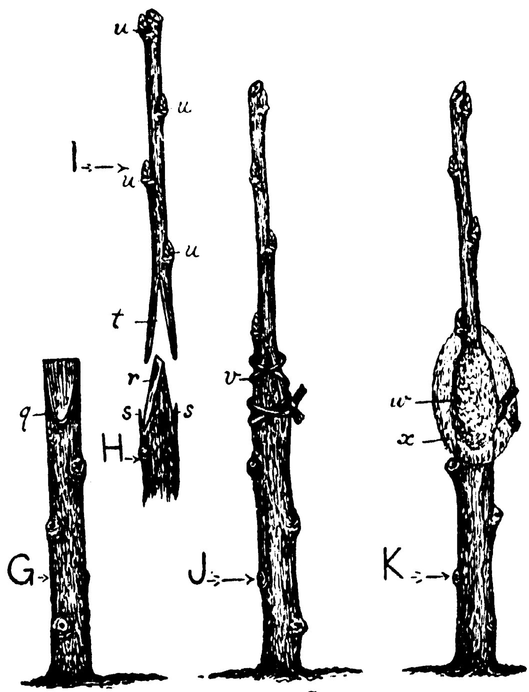

FIG. 2.—SADDLE GRAFTING.

G, stock sliced on one side to be repeated on corresponding opposite side: q, point of making downward cut. H, top of stock properly prepared: r, wedge-like form; s, tongues or downward cuts. I, scion or graft prepared for placing on stock: t, saddle-shape of lower part made by two cuts; u, buds. J, graft properly placed on stock, the two inner barks coinciding, at least on one side of stock: v, ligature securing graft to stock. K, junction of stock and graft cuts or wounds: w, waxed: x, clayed, not both

Another method is what may be termed the "Somerset" saddle (Fig. 3), as it is more practised in that county than any other. It is a better and stronger method than the last, and can be used on stocks up to an inch in thickness. Sometimes it is employed for even larger ones up to two inches thick, in which case two are put in on opposite sides,

the end of the stock being cut square instead of on the slant. In either case, making the cuts in the graft is an operation needing a good deal of skill and practice. In the method under notice the stock is prepared by a longish cut on one side only. A slit is then made in the bark on each side in just the same way as for bark or rind grafting (see below).

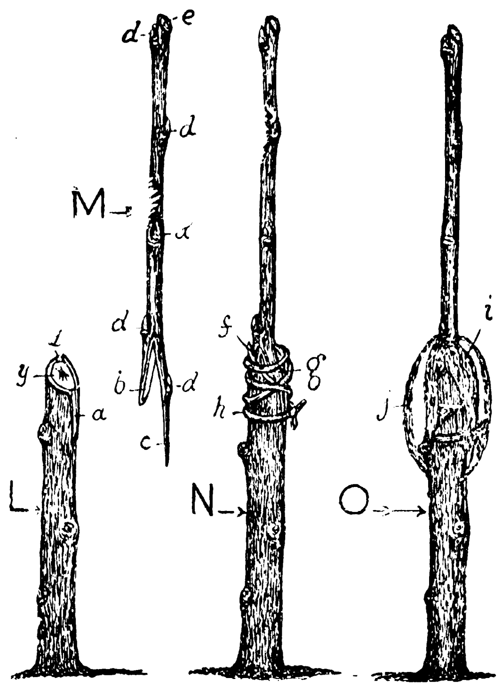

FIG. 3.—"SOMERSET" SADDLE GRAFTING.

L, stock prepared for graft: *y*, longish or slanting cut top when stem severed at proper height; *z*, slit made vertically in bark at highest point of slanting cut; *a*, slit made at lowest point of cut. M, scion or graft: *b*, short cut side of saddle; *c*, long or "strap" side of saddle; *d*, buds; *e*, top cut slanting on opposite side of bud. N, graft affixed on stock: *f*, short cut side of graft inserted under bark in slit; *g*, "strap" or long side of graft across cut of stock and under the bark on the lower side; *h*, ligature. O, junction of stock and scion wounds: *i*, waxed; *j*, clayed—one of these, not both.

If the sap is "up" the bark should part easily from the wood on giving the knife a slight twist on each side of the cuts. The first cut in the graft would be about an inch long (Fig. 3) and rather thick, or about half way through when it reaches the upper end to a bud. The other cut, to form the "strap," is double the length and thinner to allow for bending. At the upper end, when nearly opposite the first one, this cut is turned in at a more acute angle, when the wood should drop

out. The short cut side is inserted under the bark on the top of the cut on the stock, the "strap" going across and under the bark on the lower side ; after which the graft is tied and waxed. If the graft takes properly and the stock is not too wide, it soon grows over the cut, and in a few years completely covers it.

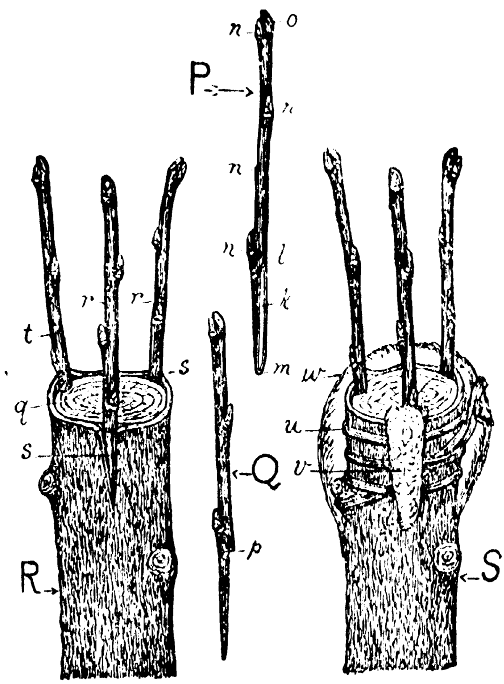

FIG. 4.—CROWN OR RIND GRAFTING.

P, scion or graft prepared by slicing : *k*, slice cut off one side opposite a bud at the upper end, *l*, and the bottom cut away to nothing, *m* ; *n*, buds ; *o*, top cut sloping from a bud. Q, graft prepared with a shoulder : *p*, point where cut made partly through, and with lower portion cut off to nothing forming shoulder to rest on top of stock. R, stock or limb : *q*, point where cut off ; *r*, grafts with simple sliced off sides inserted in slits, *s* ; *t*, graft with shoulder resting on top of stock. S, stock or limb after completing grafting : *u*, ligature ; *v*, waxed over cuts or wounds, or *w*, clayed over top of stock as well as slits.

In neither of these forms of saddle should the graft be split when preparing it, or when placed across the stock the split may extend and the graft become useless.

Scions or grafts for the foregoing methods of grafting are usually selected from well-developed one-year-old shoots, but for grafting older and larger trees as in the following methods two-year-old wood bearing wood-buds may be used in addition to stout one-year-old wood.

Crown or Rind Grafting.—This (Fig. 4) is the simplest method of all, and chiefly used on big branches of possibly

oldish trees. The branches to be utilized as stocks should be sawn off some few weeks before grafting time, and a few inches higher up than where they are to be grafted, being cut off again just before the grafts are put on. If the saw cut is pared over with a knife, the bark soon heals over. If the branch is growing upright a slightly sloping cut must be made to allow water to run off.

A slit is made through the bark, which is parted from the wood either by twisting the knife or, preferably, with a smooth flat piece of bone or hard wood about the size of

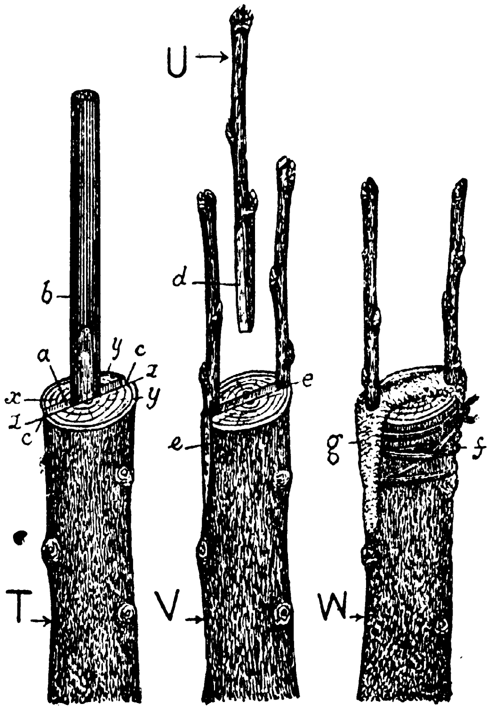

FIG. 5.—CLEFT OR WEDGE GRAFTING.

T, stem or branch prepared : *x*, point where cut and edges of bark pared smooth, *y* ; *z*, point where split with hammer and chisel ; *a*, cleft kept open by iron or wooden wedge, *b* ; *c*, sides of cleft pared smooth and straight. U, scion or graft : *d*, lower end cut wedge-shaped. V, stem or branch with grafts properly inserted : *e*, inner barks entirely coinciding. W, operation completed : *f*, ligature ; *g*, waxed over cleft and wounds.

the graft. A slice about two inches long is now cut off one side of the graft, the upper end of the cut being opposite a bud and the bottom cut away to nothing; the graft is then slid between the bark and the wood. By cutting off a thin bit of bark on each side of the slit, the bark will return to its place next the wood. Several grafts may be put on in this way, each one being cut so that the leading buds point

in opposite directions to grow away from each other. In all methods the grafts should be cut in such a way as to have a bud near the "collar" of the stock, which *bud*, when it grows, will assist in forming a strong union. After tying, just sufficient wax should be applied to cover and exclude air from the wounds or cuts.

Cleft or Wedge Grafting.—This is a very firm and sure method, but on rather large branches it is open to the objection that the moisture gathers in the cleft and decay commences in the wood. The branch is split with a hammer and chisel, the cleft being kept open with a wooden wedge. The sides of the cleft are pared smooth and straight, and the grafts cut wedge-shaped and inserted one on each side. The wooden wedge is removed, and the cleft, reducing in size, holds the grafts very firmly. Tying is hardly required, but it is safer to do it. Enough wax should be used to fill in and cover both cleft and wounds as before. (*See* Fig. 5.)

General.

Very soon after grafting time, the buds and young branches will begin growing from the stocks. They should be left for a time in order to encourage the sap to circulate, but when the grafts grow, be gradually reduced but not removed altogether during the first year.

Both wax and clay are used to exclude air from the wounds. Wax has been recommended throughout, as it is in many ways preferable to clay. It is much cleaner to use, and can be more easily and quickly applied, while there is not the same shelter under it for American blight. A good wax for using warm or cold can be made with equal parts by weight of Burgundy pitch, kerosene wax, and tallow (melted candles will do), or, as tallow smells rather strongly while being melted, olive oil may be preferred. The materials should be melted together in an old saucepan, and if used warm the mixture can be put on with a paint brush, or if cold with a putty knife. At the cost of not more than eighteenpence, enough can be made for several hundreds of grafts.

Clay is cheaper, but cannot always be obtained ; it may be used in its natural state, according to the "temper" of the clay, or mixed with a third part of cow-dung. Cow-dung is also used alone, and also bands of hay and clay.

If the wax made as described is employed, it will remain fairly soft, and when the grafts grow well, about midsummer, if a slit is made in the raffia both wax and raffia will be pushed off by the swelling of the grafts.

Whitehall Place, London, S.W.1,
April, 1906.
Revised, December, 1915.

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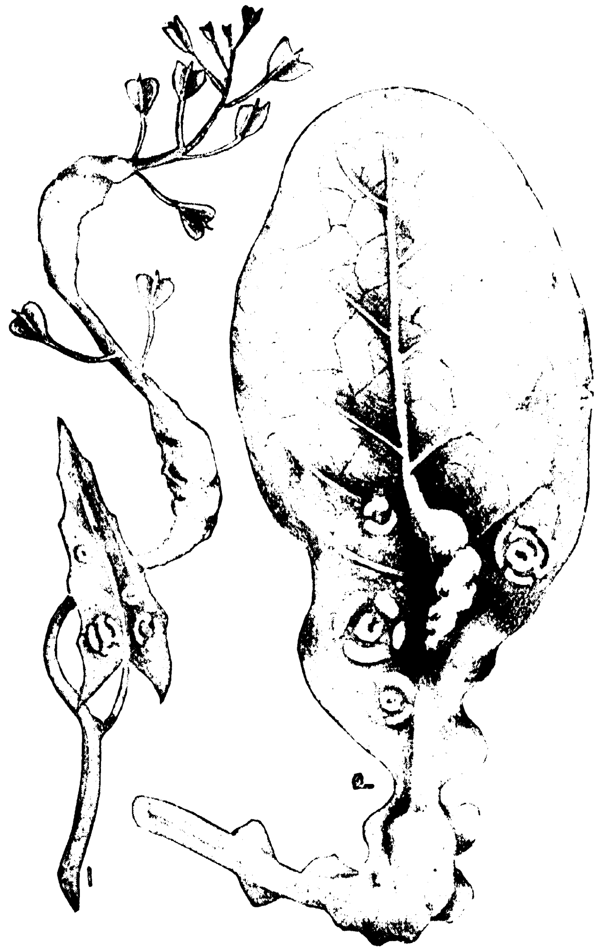
Leaflet No. 163.

BOARD OF AGRICULTURE AND FISHERIES.

White Rust of Cabbages (*Cystopus candidus*, Lév.).



White Rust—(1) on Shepherd's Purse; (2) on Young Cabbage Leaf.

This destructive fungus has a world-wide distribution, and attacks many kinds of plants belonging to the cabbage family — *Cruciferæ* — both cultivated and wild. In this country the various forms of cabbage radish, and horse-radish suffer most from its presence; among wild plants the Shepherd's purse is most frequently attacked (Fig. 1).

Description.

On the leaves the fungus forms snow-white polished blotches, which are often grouped in irregular concentric rings (Fig. 2). At maturity, these white patches break up into a powdery mass and the spores are scattered by wind and rain. Infection can only take place during the seedling stage, and this can practically be prevented by selecting a fairly dry and open situation for the seed-beds, as the zoospores or infecting bodies can only perform their functions in the presence of an excess of moisture. When the stem or flower is attacked much distortion and swelling is produced, and in the swollen parts numerous resting-spores are formed, which germinate and infect seedling-plants the following season.

Prevention and Remedy.

1.—Diseased leaves should be removed the moment the fungus is observed, but the most important point to attend to is the collection and burning of all swollen and contorted stems and flowers, as it is the spores present in these swollen parts that infect seedlings in the spring.

2.—Shepherd's purse should be eradicated, as this weed is, in the majority of instances, the host and primary source of infection of cultivated plants.

Whitehall Place, London, S.W.1,
March, 1906.

Revised, February, 1913.

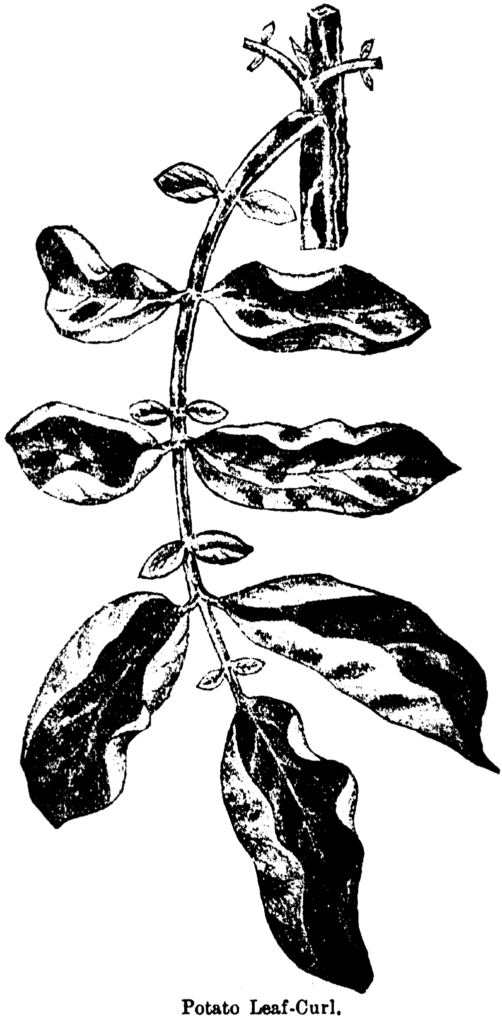
Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 164.

BOARD OF AGRICULTURE AND FISHERIES.

Potato Leaf-Curl and Black-Stripe of Tomatoes

(*Macrosporium solani*, Cke).



Potato Leaf-Curl.

This disease is widely diffused. In addition to Britain, it occurs on the Continent, and is rampant in the United States. It has also occurred on *Solanum Commersoni* grown at Kew. (The "Leaf-roll" disease of potatoes in Germany is distinct, and is considered a physiological disease.)

Black-stripe of Tomatoes was formerly considered to be caused by a fungus named *Macrosporium tomato*, Cke. It has, however, been found that *M. tomato* is identical with *M. solani*, the difference in the appearance of the fungus on the two plants respectively being due partly to the host, but more especially to the fact that in the potato the fungus behaves as a perennial, its mycelium hibernating in the tubers, and growing along with the vegetative portion of the plant. In the tomato, however, there is no hibernating mycelium, and the fungus behaves as an annual, more especially infecting the fruit as a wound-parasite, but sometimes also infecting the stem and leaves. The disease, as manifested in the two plants, is dealt with separately.

POTATO LEAF-CURL.

In the case of the potato the haulm is more or less stunted, the foliage is small and the leaflets are much curled. In many instances the shoots do not appear above-ground, and gaps are left in the rows. The haulm is infected either by hibernating mycelium passing directly from the tuber, or by means of spores present in the soil, which infect the young sprouts. In either case the arrest of growth and the curling of the leaves is due to the ascent of water and food being checked by the upward growth of the fungus mycelium in the tissues of the haulm. As the mycelium increases in quantity the haulm becomes limp and collapses, owing to lack of water.

Even if a tuber contains no hibernating mycelium the tubers it produces may become diseased, for if the sprouts are infected while quite small, the mycelium grows up along with the haulm, and passes into any tubers it may produce. Tubers which produce curled foliage do not decay, but remain firm and hard.

Experiments conducted at Kew show that when a tuber known to contain hibernating mycelium is planted, and the foliage shows the characteristic curl, the tubers produced by such an infected tuber do not perpetuate the disease *if they are lifted some time before they have completed their growth.* This suggests that the mycelium only passes from the haulm into the tubers during the last stages of growth, and further suggests that tubers intended for "seed" should be lifted before they have completed their growth. This, perhaps, explains the comparative freedom from leaf-curl of Scotch "seed," which, in the case of late or maincrop varieties, is invariably lifted in an immature condition.

It is also known that after having been grown for two or three years in the South of England, Scotch "seed" contracts leaf-curl, probably owing to the tubers being allowed to reach maturity before they are lifted, when they become infested with mycelium through infection of the sprouts as indicated above.

After the mycelium has passed up the haulm and into the leaves, the fungus breaks through the tissues and produces its fruit in the form of numerous irregular, blackish, minutely velvety patches scattered over the surface of the haulm and leaves.

Preventive Measures.

1.—Preventive measures will consist in not planting "sets" which were grown in an infected area; where the disease has occurred the haulms should be collected and burned. otherwise the spores will infect the land.

2.—It is important that tubers intended for "sets" should be lifted before they reach maturity. This appears to be the most practical method of preventing the introduction of the disease.

3.—A dressing of kainit in the rows when the potatoes are planted would to a certain extent safeguard the crop, by killing spores present in the soil at the time of germination. Spraying is of no avail.

BLACK-STRIPE OF TOMATOES.

This disease is sometimes known as Black Rot. The fruit is most frequently attacked, discoloured patches appearing, which become slightly sunken owing to collapse of the tissues. Such patches soon become covered with a delicate velvety pile of a blackish-olive colour. The fungus sometimes forms long, blackish stripes on the stem, and irregularly shaped blotches on the leaves.

Preventive Measures.

1.—Cleanliness is of primary importance. If all diseased material is promptly burned no spores can exist to start an epidemic. Infection can only take place through a wound. Minute cracks on the fruit in the neighbourhood of the style, exposing the fruit to infection, are often the result of over-feeding, more especially when green stable manure is used.

2.—The fact must be kept in mind that the spores produced on the tomato plant may infect a potato plant, and *vice versâ.*

Whitehall Place, London, S.W.1,
April, 1906.
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Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1 Letters of application so addressed need not be stamped.

Leaflet No. 165.

BOARD OF AGRICULTURE AND FISHERIES.

GALL-GNATS INJURIOUS TO WILLOWS AND OSIERS.

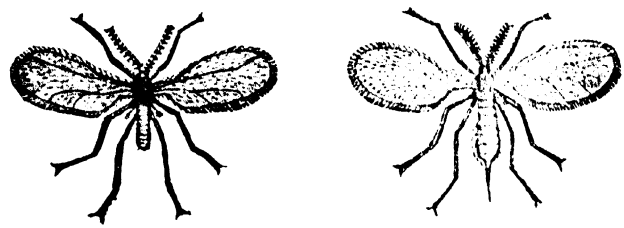

FIG. 1.—*Cecidomyia saliciperda* (magnified). Male to left, female to right. After Nitsche.

The Gall-Gnat Family, or *Cecidomyidæ*, is a family of two-winged or dipterous insects. These flies are tiny, delicate in structure, and with few nervures to the wings ; their somewhat long antennæ have, typically, whorls of fine hairs at the joints ; the legs are long and slender ; the wings and body bear hairs which are easily rubbed off. The larvæ are small maggots, and on the lower surface of the front end of the body some have a so-called anchor-plate, or "breast bone," which may be used for leaping, for changing position, or perhaps in feeding.

The food habits of the larvæ vary considerably, but all the willow-infesting species are found in characteristic galls or malformations, the galls being on young or older twigs, at the apices of twigs, on flower buds, or on leaves.

The pupal stage is generally passed in the gall, but in some cases in the soil.

Cecidomyia (Rhabdophaga) saliciperda.

This species infests *Salix alba*, *S. fragilis*, *S. caprea*, *S. purpurea*, *S. viminalis*, and, sometimes, the White Poplar, *Populus alba*. Young twigs and also branches up to 3 or 4 inches in diameter are attacked.

Symptoms of infestation are poor leafage, swellings, and later on the rupture of the bark, which hangs down in shreds.

Description.

The *fly* (Fig. 1) measures about $\frac{1}{8}$ inch in length ; its head and thorax are black, or black-brown, with black hairs ; the wings are milky white, with whitish hairs.

The *eggs* are extremely minute, rounded at the ends, and orange yellow in colour.

The *larva* (Fig. 2) is rounded at both ends, or somewhat spindle-shaped, and has a well marked anchor-process.

The *pupa* is yellow, and has two small brown projections at the base of the antennæ.

Life History.

The female deposits her eggs in chains or rows on the bark. The larvæ on hatching bore into the bark (Fig. 3), and owing to their irritating presence the cambium gives rise to irregular streak-like growths, through which the larvæ make excavations or irregular galleries. Between the larval galleries the wood is normal in condition. Perhaps the activity of the cambium may serve to enclose the larvæ without marked boring on their part.

FIG 2.

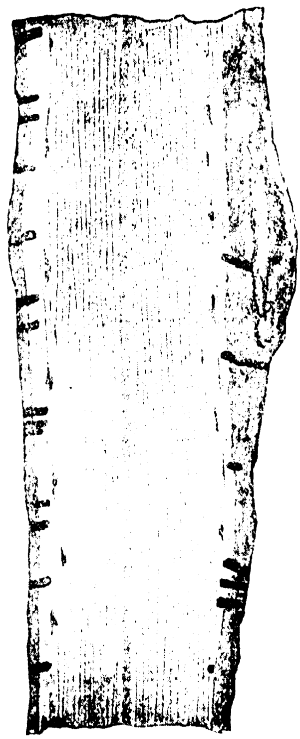

FIG. 4. FIG. 3.

FIG. 2.—Larva of *C. saliciperda*, after preservation, greatly magnified. FIG. 3.—Longitudinal section of *Salix alba*, showing larval tunnels of *C. saliciperda*, natural size. FIG. 4.—Piece of *Salix alba* showing flight holes of adult *C. saliciperda*, natural size.

For a time the bark stretches, accommodating itself to the increased thickening, so that only spindle-shaped swellings show, but ultimately it ruptures and hangs down in shreds. Pupation takes place just under the bark, which is easily knocked through by the forehead of the pupa.

After the issue of the flies the bark may be seen riddled with small holes (Fig. 4). There is one generation in the year, the larvæ tunnelling from July till the next April, May, or June.

Preventive and Remedial Measures.

1. Cut off and burn infested shoots before the issue of the flies.
2. Cut out infested pieces and burn them.
3. Apply cart grease or some similar substance to the places attacked, and although the pupæ may occasionally push themselves through this, the flies will be entangled in the sticky material.

Cecidomyia (Rhabdophaga) salicis.

This gall-gnat is the cause of spindle-shaped or lemon-shaped galls on the one-year twigs of *S. cinerea*, *S. caprea*, *S. purpurea*, *S. aurita*, and *S. viminalis*.

Both leading and side shoots may be infested. The twigs fail to grow; they may become angled and are rendered useless for basket-making or wicker-work.

The galls are caused by an enlargement of the pith.

Description and Life History.

The *flies* are black, with two stripes of white hairs, and measure about $\frac{1}{4}$ inch in spread of wings. They deposit their eggs in little heaps, and in the many-chambered gall the yellow-red larvæ may be found, in number up to 30. Pupation takes place just below an outside skin, which is broken through for the exit of the adult gnat. Issue of adults may take place from the end of May onwards.

To prevent attack on the shoots to be formed during the ensuing season cut away and burn the galls before the flight of the adults.

Cecidomyia (Rhabdophaga) rosaria.

The galls of this insect are typical of a series, in which the malformations at the ends of the twigs hinder the normal increase in length of the branches.

The galls of *C. rosaria* are rose-shaped and are found at the ends of the shoots of *S. caprea*, *S. aurita*, *S. alba*, *S. purpurea*, *S. cinerea*. The fly is black, with greyish wings, and has silvery hairs on the thorax.

In late spring or early summer the egg is laid in the developing terminal bud, and, the internodes failing to develop, the leaves remain drawn together in a rosette.

When the other leaves fall in autumn, those of the gall remain, brown and withered looking. Pupation takes place in the gall.

Cecidomyia (Dasyneura) terminalis.

This brown-black fly is the cause of the swollen galls at the apices of the shoots of *S. fragilis* and *S. alba*.

As many as 20 to 30 larvæ may be found in the gall.

Cecidomyia (Rhabdophaga) heterobia.

FIG. 5.—Galls of *Cecidomyia heterobia* on *Salix triandra* (two-thirds natural size).

This gall-gnat is the cause of the rosette galls (Fig. 5) at the apices of the shoots of *S. triandra* and *S. cineria*, and of the galls on the male catkins of *S. amygdalina*.

The infested catkins are deformed, while the presence of the larvæ at the apices of the shoots prevents shoot development.

This gall-gnat is dusky-brown to black in colour, with the under surface of the abdomen yellow. Pupation takes place in the gall. The damage, as in 1904, may be very great.

The varieties of osier chiefly attacked by this insect are known in the trade as Norfolks, Black Mauls or Mules, and Spaniards, these all being varieties of *S. triandra*.

The remedial measure is to cut away the galls and burn the enclosed brood.

Cecidomyia (Dasyneura) marginem-torquens.

This gall-gnat may be mentioned as a type of those that cause galls on leaves. The galls occur at the edges of the leaves, and as there may be many side by side—one larva to each gall—the leaf edges are rolled. *Salix viminalis* is a favourite host plant, but *S. fragilis* may be infested, and there is a record of attack on *S. caprea*.

Whitehall Place, London, S.W.1,
May, 1906.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 166.

BOARD OF AGRICULTURE AND FISHERIES.

Some Common Thistles.

In another leaflet* a general account is given regarding the dangers of weeds, the manner of their distribution, and the methods by which they may be suppressed. Inasmuch as certain species, however, demand special measures, it is proposed in the present leaflet to describe several of the commoner species of thistle which arrest the farmer's attention both on arable and pasture land, and to point out how they may be dealt with in a systematic manner. These pests are: (1) *The Spear Thistle*, (2) *The Welted Thistle*, (3) *The Marsh Thistle*, (4) *The Creeping Thistle*, (5) *The Stemless, Dwarf or Chalk Thistle*, (6) *The Annual Sow Thistle*, and (7) *The Perennial Sow Thistle*. The spear, marsh, creeping and stemless thistles have each hair of the down or pappus which is attached to the "seed," branched somewhat like a feather, while the hair of the down of the other three species named is simple.

All the species flower during the summer months, between July and September, but while the Annual Sow Thistle may flower in June, the Perennial Sow Thistle and the Stemless Thistle flower late, about August and September.

Description.

1.—THE SPEAR THISTLE (*Cnicus lanceolatus*, Willd.) is the strongest of the plants mentioned, and grows usually from 2½ ft. to 4 ft. high (Fig. 1). Its root is a well-developed tap-root, which descends from 9 in. to 1 ft. into the soil, and bears few lateral roots. One or two very strong adventitious roots, however, are often produced near the surface of the ground. The upright stem is stiff, and the spines on the edges of the leaves are long and stout. There are also short stiff spines on the upper surface of the leaves, and long ones on the bracts forming the involucre of the flower-head. The flower-heads are erect and comparatively few, and are placed either singly or two or three clustered together at the end of the branches. Each head is about 1 in. to 1½ in. in diameter,

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* Leaflet No. 112. Weeds and their Suppression.

with pale crimson-purple flowers (Fig. 2). The plant produces seeds freely, and these germinate very easily in two or three days when they are placed in suitable soil. The

FIG. 1.—SPEAR THISTLE (*Cnicus lanceolatus*, Willd.), clearly showing its spinous character.

spear thistle as met with in the fields is usually a biennial. Seedlings have, however, been artificially flowered in one season, but such plants did not ripen seeds satisfactorily, and

were destroyed by frost in the autumn. Ordinarily the plant during the first season of growth produces a compact rosette of ovate-lanceolate leaves lying close to the ground. In the second year a central stem is sent up, which branches and bears flower-heads in which seeds are produced. After the latter are ripe the plant dies. The seeds, however, are borne away from the parent plant by means of the feathery

FIG. 2.—HEAD OF SPEAR THISTLE (*Cnicus lanceolatus*, Willd.), about natural size.

down or pappus. The distance which the seed is carried is comparatively short, usually less than 30 or 40 yards rather than beyond this distance, and it varies with the state of the weather. On dry, hot days the seed separates or dries off the pappus almost as soon as it escapes from the

flower-head and drops to the ground close to the plant, the pappus floating away without its load. Most of the thistle down seen floating on windy days bears no seed. The spear thistle is very common on roadsides, and in pastures and meadows on almost all kinds of soil throughout the country.

2.—THE WELTED THISTLE (*Carduus crispus*, L.) is an annual or biennial plant, not so commonly distributed as the preceding one, and it gives little trouble to the farmer. The tap-root is smaller and the stems more slender than those of

IG. 3.—*Left :* CREEPING THISTLE (*Cnicus arvensis*, Hoffm.) ; *Right :* MARSH THISTI (*Cnicus palustris*, Willd.).

the spear thistle. The stem is erect, about 1 ft. to 3 ft. high, winged, and covered with fine spines. The leaves and involucre are also covered with spines. The flower-heads (Fig. 6*d*) are roundish, clustered together at the end of the branches, and bear purplish-crimson flowers. The seeds germinate very readily, and the young plants somewhat resemble those of the spear thistle.

3.—THE MARSH THISTLE (*Cnicus palustris*, Willd.) is one of the commonest species, and is met with all through the country on damp undrained pastures and by the sides of ditches. The root-system of the plant consists of a series of fibrous roots all about the same thickness. The stem (Fig. 3) is erect and branched, somewhat slender and soft, with numerous short spines upon its wings. The whole plant is of a dull green or greenish-purple tint. The flower-heads (Fig. 6*c*) are small, about ½ in. in diameter, and bear dark purplish-crimson flowers. The involucre is practically spineless and similar in colour to the stem. The plant is a biennial. During the first season a compact rosette of leaves is formed close to the ground, from which an erect stem is sent up in the second year. The seeds are pale straw-coloured, and only germinate satisfactorily under the peculiar acid conditions of marshy, damp soil.

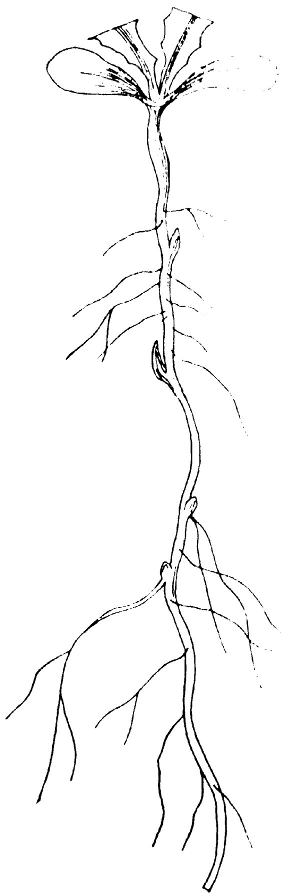

FIG. 4.—CREEPING THISTLE. Seedling 9 weeks old (slightly reduced).

4.—THE CREEPING THISTLE (*Cnicus arvensis*, Hoffm.) is the commonest and most troublesome of all thistles (Fig. 3). It grows abundantly on all sorts of arable land and pastures throughout Europe. It is a perennial plant, exhibiting many remarkable structural and biological features. The flowers have an odour very strongly resembling that of honey, and quite distinct from that of other species. In the thistles previously mentioned each flower in the head possesses anthers which bear pollen, and an ovary capable of producing seed. Moreover, in these species seed is abundantly produced in each head of flowers. The creeping thistle has, however, two distinct types of flower-head. In one of these

the flowers have abortive anthers which produce no pollen, while in the other pollen-bearing anthers are present. These

FIG. 5.—ROOT OF CREEPING THISTLE.

a b c d

FIG. 6.—FLOWER HEADS OF THISTLES (natural size).

a.—Creeping Thistle (anthers perfect). b.—Creeping Thistle (anthers abortive).
c.—Marsh Thistle. d.—Welted Thistle.

two kinds of flower-head (Fig. 6, *a* and *b*) are always borne on separate plants, and as each individual plant is capable of spreading extensively below ground and sending up stems into the air from its underground parts, distinct colonies bearing one or other type of flower-head are sometimes met with occupying comparatively large areas. A great many farmers believe that the seed of the creeping thistle is incapable of germination. This is, however, a mistake. A

FIG. 7.—THE STEMLESS THISTLE (*Cnicus acaulis*, Willd.).

certain amount of seed is produced in both types of flower-head, but chiefly in those in which pollen is absent. The seeds germinate readily enough either in the year in which they are produced or in the following spring. The seedlings have two fleshy cotyledons, soon followed by the ordinary leaves, which do not grow in rosette form as in the other kinds

of thistle. A thin tap-root descends vertically into the ground, and in a very few weeks—long before the cotyledons decay—adventitious buds are produced upon it (Fig. 4), and also upon the lateral secondary roots in great abundance. The root-system (Fig. 5) develops in all directions very extensively

FIG. 8.—ANNUAL SOW THISTLE (*Sonchus oleraceus*, L.).

both in young and old plants, and upon all parts of it buds arise which ultimately come above ground and grow into strong, leafy stems. To make matters worse from the farmers' point of view, the roots are often very deeply seated

in the soil, while small broken pieces easily take root and become new plants. Though the creeping underground parts, from which the thistle gets its common name, look very much like rhizomes, they are true roots, which bear buds ; no rhizomes are produced. The stems and leaves, both of seedlings and mature plants, are very sensitive to frost. The first frosts of November and December kill off all the green parts above ground, but the buds on the roots below are uninjured, and it is from these that the plant is chiefly propagated.

5.—THE STEMLESS OR DWARF THISTLE (*Cnicus acaulis*, Willd.), sometimes termed the Chalk Thistle from its habit of growing freely in pastures over chalk, may be at once recognised by its spreading rosette or tuft of very prickly smooth leaves, its almost stemless or sessile flower-heads, and its extensively creeping rootstock (Fig. 7). It is a perennial which sometimes occurs plentifully in dry pastures over gravel and chalk in the southern and central midland counties of England. The rosettes of leaves destroy the patch of herbage which they cover.

6.—THE ANNUAL SOW THISTLE (*Sonchus oleraceus*, L.) is a weed which causes considerable trouble in arable land. It is an erect plant which may attain three feet in height, and has a tubular grooved stem, which is branched, smooth, and shiny (Fig. 8). The leaves are bright green, the lower ones being stalked and much lobed, the upper lobed, or entire and angular, and clasping the stem. The yellow flowers, which appear in summer between June and September, are borne in crowded "heads," which are smooth or slightly cottony. The fruit is attached to a simple hairy pappus, which enables it easily to be borne away and distributed by the wind ; it should be remembered that this weed is only propagated by seed. It is widely distributed on most soils, but appears to grow most freely on medium sandy and calcareous loams.

7.—THE PERENNIAL OR CORN SOW THISTLE (*Sonchus arvensis*, L.) may be at once distinguished from the Annual species in the mature stage by means of its extensively creeping rootstocks and much larger flowers. It attains 2 to 4 ft. in height ; the stem is tubular and angular and clothed with yellow sticky hairs in its upper part ; the leaves are wavy and toothed, but very variable ; and the heads of yellow flowers are rather hairy, and 1 to 2 inches in diameter. It spreads both by seed and by the creeping rootstock. The flowers open later than in the case of *S. oleraceus*, in August and September, at which time the latter species is producing seed. The Perennial Sow Thistle is a vigorous grower, occurs on all soils in arable land, and may occasion great

trouble and damage. Its presence is frequently manifested in corn crops in late summer, when the large yellow flower-heads are very conspicuous.

Methods for the Extermination of Thistles.

The methods adopted for the destruction of thistles, if they are to be of any use, must take into consideration the life-history of the plant. The old rhyme which advises leaving the cutting of thistles until July is excellent so far as the spear, welted, and marsh thistles are concerned, but it is absolutely useless for the checking of the creeping thistle. In fact general advice for all kinds of thistles is valueless.

1.—*Destruction of Spear, Welted and Marsh Thistles.*—The spear, welted, and marsh thistles are all biennials and can be destroyed by the same methods. Each plant grows but two seasons, at the end of which it exhausts itself in seed production and dies. *In the case of these three thistles seeding must be prevented. This can be done by cutting with a spud below ground, or with a scythe, sickle, mowing machine or thistle-cutter above ground in late June or July*, when the plants have sent up their flowering stems, and before the flowers have opened. Cut at this time they die (as they would do in another month or two in any case) and seed is not formed. This plan effectually gets rid of plants which are in their second season of growth. Seedlings must, however, be dealt with also. These are best spudded in meadows and pastures in late autumn and in spring. At this time they are in the form of a rosette close to the ground. In cutting with the spud or similar instrument it is important to be certain that the roots of the plant are cut through below the bud part from which the leaves arise. It must also be borne in mind that in the case of the marsh thistle there are a number of roots to be severed, and the spear thistle and welted thistle often have more than one strong root. Sometimes one of the roots is cut and the other left, but this is quite useless. *To make certain of the result, the spud should be driven well below the surface of the land and the severed rosette of leaves turned upside down.* It is easily done, and requires no more time than slovenly work. Cutting at these definite times of the year, namely, in autumn and spring for the eradication of the young plants, and in June or July for the destruction of the old ones so as to prevent seeding, is all that is necessary in the case of the three kinds of thistles mentioned.

2.—*Destruction of Creeping Thistle.*—The creeping thistle cannot be destroyed by the methods outlined above. Seeding must, of course, be prevented, but to wait until June or July before cutting is an excellent way of keeping this pest in a state of robust health. During the summer the plants manufacture a large amount of food-material in their leaves,

and this is transferred and stored below ground in the roots and root buds. Comparatively little seed is produced, and little of the stored food is needed for it. To cut off the stems after this storage has taken place has no exhausting effect on the crop, and the mowing of this kind of thistle once or twice *late in the season* can be practised for years without diminishing its vigour. *To cope with the creeping thistle it must be cut early in the year, soon after it comes above ground, and the cutting should be repeated as frequently as possible throughout the season.* For every shoot sent above ground the thistle uses some of its stored material, and if the stems and leaves, which are the plant's machinery for making more food, are destroyed as soon as they appear, exhaustion and death certainly result. Both old and young plants must be dealt with in this way. *Faithful systematic cutting with the spud or scythe in meadows and pastures throughout two seasons, or the growth of a couple of root crops in succession where the weed is very prevalent in arable land, is a sure plan of getting rid of this most troublesome agricultural pest.*

Experiments conducted at the Harper Adam Agricultural College in 1907, 1908 and 1909, showed that the Creeping Thistle may be destroyed in three years in grass land by cutting three times in the first and second seasons (in early June, late July, and once later), and twice in the third year (in early June and late July). Cutting was found to be best done when the plants were 4 to 6 inches above ground.

In the United States it has been found that small patches of the Creeping Thistle may be destroyed by covering the plot of infested ground with large sheets of strong tarred paper, securely fastened down with pegs and large stones. Light is excluded and all vegetation beneath the paper is destroyed.

3.—*Destruction of Stemless Thistle.*—The creeping rootstock and almost stemless character of this thistle combine to make eradication extremely difficult, for it is a perennial which stores food in the same way as the Creeping Thistle. It is not tall enough to be cut with the scythe or other implement, and it sometimes occurs in such numbers that continual spudding is a most tedious and expensive operation. Spudding, however, is the only practical mechanical remedy, and should be repeated throughout the summer months. An endeavour should at the same time be made to improve the general herbage by manurial treatment, and thus crowd out the low growing thistle. Isolated patches might be dealt with by the tarred paper method mentioned above, but the bare spots would need reseeding with grass and clover seeds afterwards.

4.—*Destruction of the Annual Sow Thistle.*—As this thistle is an annual only propagated by seed, it is clear that where it occurs, either in small or large quantity, the first thing to be considered is the prevention of seeding, and to this end it is important that the plants should be cut down before the flowers appear. The cutting of the plants, moreover, should not be confined to the fields actually infested, but (as with all other species of thistles) should extend to any waste land which may be adjacent, for such land is usually a fertile source of the thousands of plants which are found in cultivated fields. Cutting off with the hoe below the surface of the soil, or pulling up by hand, is equally effective in destroying the annual sow thistle. The easiest time for hand-pulling is when rain has softened the ground, and in corn crops this is doubtless the most expedient method. The regular and thorough hoeing generally practised will keep this weed down in root crops, and the same remark applies to garden cultivation. Surface cultivation with the harrow in spring destroys thousands of the seedlings.

5.—*Destruction of the Perennial Sow Thistle.*—This species may be combated in the same way as the Creeping Thistle (*Cnicus arvensis*), as its habits are very similar, it being propagated by seed and by creeping rootstocks which store up food during the period of growth in summer. A short rotation, with thorough cultivation and the free use of the hoe in two or three successive root crops, is perhaps the most certain means of killing this pest. Badly infested land may be laid down to grass for a few years, when the weed will be crowded out. Small patches may be destroyed by the use of tarred paper, as in the case of the Creeping Thistle.

Heavy crops of lucerne, vetches and maize tend to crowd out thistles of all kinds, and where it can be grown successfully maize is especially useful, as it casts a dense shade and is thoroughly hoed.

Whitehall Place, London, S.W.1,
May, 1906.
Revised, September, 1910.

Other Leaflets on Weeds published by the Board are:—

No. 63.—The Destruction of Charlock.
No. 112.—Weeds and their Suppression.
No. 180.—Dodder.
No. 194.—Coltsfoot.
No. 222.—Meadow Saffron.
No. 226.—Broom-rape.
No. 251.—Some Common Weeds.—I.

Leaflet No. 167.

BOARD OF AGRICULTURE AND FISHERIES.

Ducks and Duck-Breeding.

This Leaflet has been temporarily withdrawn: See statement in Prefatory Note.

Leaflet No. 168.

BOARD OF AGRICULTURE AND FISHERIES.

Hints on the Formation of Permanent Pastures.

It is difficult to give precise rules for laying down land to grass; the treatment must vary greatly under different conditions. From fifteen to twenty species of plants are usually included in the mixture for permanent pastures, and it is clear, that not only will the final result depend upon the species chosen, and upon the proportions in which they were originally present, but also on the soil, the manure, the seasons, and the manner in which the pastures have been grazed.

Preparation of the Land.

Before the subject of the seeds mixture proper is considered, it will be convenient to refer briefly to some points connected with the preparation of the land. Good grass seeds are expensive, but bad grass seeds are still more so, and hence the only way in which the cost of any particular mixture may be lessened is by reducing the seed-rate. It is plain that if the number of seeds is reduced, close attention must be given to the preliminary cultivation. In the first place, it is necessary that the soil should be thoroughly cleaned, and that annual weeds, as well as couch, should be destroyed. Small and slow-growing grasses are much more readily injured by annuals than are such vigorous plants as wheat or oats. In the second place, a fine tilth and a firm surface will be necessary. If the ground is rough, a number of the seeds must perish; bare patches will thus be formed, which will subsequently extend and disfigure the pasture. If the soil is soft and open, seeds may be buried too deeply, and the "plant" will be thin. It is generally best to sow on a bare rolled surface, harrow in lightly, and then roll again at once. A further important consideration in preparing land for grass and clover plants, is the manurial condition of the soil. Although grasses are benefited by nitrogenous manures, it will seldom be desirable to apply such manures, either just before or immediately after sowing the seeds. The first effect of the manuring would be to increase the quantity of straw produced by the corn crop with which the seeds have been sown, and thus to repress rather than aid the young pasture plants.

Phosphatic manures, such as basic slag or superphosphate, on the other hand, should be used liberally, and may perhaps be best applied to the preceding root crop. If the root crop has not received either of these artificial manures, one or other may be worked into the land before sowing the seeds. In dry districts and on light soils, 3–5 cwt. of superphosphate should be applied in spring, but for most soils, 4–6 cwt. of basic slag may be recommended. This manure may be applied at any time between November and March, when the soil is in suitable condition. If farmyard manure has been used freely (12–15 tons per acre) for the root crop, and if part of this crop has been consumed on the land, a potash manure may usually be dispensed with; and even where roots have been carted off, potash manures are not likely to be required before sowing, except on light gravelly, or on light peaty soils.

How to buy Grass Seeds.

The purchasers of grass seeds may broadly be divided into two classes, those who let others choose their seeds-mixture, and those who select their own. In the first class are those who have no knowledge of grasses, and who, for various reasons, are unable to give the subject personal consideration. This large class may be recommended to go to those seedsmen who have made grasses a speciality, state their requirements, and leave the selection of the seeds to the merchant. The cautions which may be given to a farmer of this class are the following:—Be quite sure of your seedsman, remember that grass seeds are liable to impurities, and are frequently of low quality; further, that these defects, though easily detected by the expert, may not be within the knowledge of the ordinary trader. A merchant may be perfectly honest, but if he has not given close attention to grass seeds and their impurities he may supply unsatisfactory seeds. When quotations are asked for, the seeds of the best seedsmen may appear to be expensive, but a man who has no special knowledge must pay for the special knowledge of others, and in the case of grass seeds, this knowledge is usually well worth paying for.

The mixtures prepared by our seedsmen are compounded on the principle of sowing down a full supply of every plant which is likely to suit the soil. These mixtures usually furnish from sixteen to twenty millions of seeds per acre at a cost of 20*s*. to 40*s*. The only method of reducing the cost—which can be recommended to the farmer who is ignorant of the grasses—is to sow less seed, say 20 lb. to 30 lb. instead of the 30 lb. to 40 lb. usually put in. The seedsman recommends 30 lb. to 40 lb. for soils in "fair average condition,"

but if by skilful tillage and manuring the land is got into first-rate order, the quantity to be sown may safely be reduced. By sowing good seeds, and by farming well, the farmer who has no special knowlege may succeed in forming good pastures, even upon land of medium quality; but he cannot expect to obtain either the best or the most economical results, and he will seldom succeed on poor land, or upon land that has not been liberally manured. To be successful in forming pastures, the farmer must understand the special cultivation required by pasture plants, and must treat them with the same intelligence that he now bestows on corn and roots.

The stages in a Pasture's existence.

The hints which follow are addressed to farmers who wish to choose their own seeds, and improve on their present system of laying down land to grass. These hints are based on an article published in the Journal of the Board.* It was pointed out in that article, that a pasture passes through three clearly defined stages of existence, that a somewhat different type of herbage is associated with each stage, and that the management must vary with the type of herbage which may cover the soil at any given time.

The first stage of the pasture's existence lasts for from two to three years, and on almost all soils, rye-grass and red clover predominate in the herbage. The red clover soon begins to disappear, and a rapid change then sets in; the soil appears to have become exhausted, the rye-grass gets poor and thin, and for a time the deterioration is very marked. This stage of poverty may last for from three or four years on good soil, up to ten or twenty years on poor land; indeed, on very poor, neglected pastures, this second stage will continue indefinitely. The characteristic of the second stage is the absence of turf, so that everywhere bare soil shows through the herbage. This bareness is nearly always very marked on those pastures on which white clover does not grow freely.

On soils of fair, to good quality, fertility gradually accumulates with rest, and a turf begins to form. This slowly thickens, until on fine land, after an interval of perhaps twenty to thirty years, it forms the rich velvety covering of perennial rye-grass and white clover characteristic of our best pastures; or it may be the rougher mixture of permanent grasses, clovers, and weeds, which are common on second-rate land.

* Journal of the Board of Agriculture, Vol. XII., October, 1905, p. 385; and November, 1905, p. 449.

Seed-mixtures.

In the article above referred to, it was pointed out that pastures must *grow* old, and that the mere sowing down of plants in the proportion in which they are found, or desired, in old pastures, will not not make a pasture either good or permanent. Examples were given of experimental mixtures which had failed, and also of one which had succeeded. The particular mixture which succeeded was one recommended by Mr. R. H. Elliot, of Clifton Park, which had been sown down on a poor clay soil, in one of the experiments conducted by the Cambridge University Department of Agriculture. Mr. Elliot's mixture cost about 40*s.* per acre, and, although it was successful, many farmers would consider it too expensive.

Mixture for poor clay soils.—The following seeds are therefore suggested for those who require a cheap mixture for sowing upon poor clay soils:—

Plant.	Weight.	Number of Seeds in Thousands.	Cost.*
	lb.		*s.* *d.*
Italian rye-grass	4	1,069	1 4
Perennial rye-grass	3	635	0 10
Timothy	1	1,307	0 7
Cocksfoot	2	809	2 0
Meadow fescue...	2	467	2 6
Tall fescue	½	120	0 7½
Hard fescue	1	555	0 8
Meadow foxtail	1	441	1 4
Tall oat-grass	½	62	0 7
Golden oat-grass	¼	280	0 11
Rough-stalked meadow grass ...	¾	1,626	1 1
Smooth-stalked meadow grass ...	¾	1,085	1 0
Crested dogstail	¼	210	0 4½
Perennial red clover	1½	320	1 7½
Alsyke clover	1½	1,055	1 7
White clover	2	1,484	2 6
Lucerne	1	219	1 1
Common sainfoin (unmilled) ...	5	110	1 4
Burnet	4	259	3 3
Chicory	1	284	1 3
Yarrow	⅛	417	0 6½
Total	33⅛	12,764	27 0

* The prices quoted are calculated on the average of price lists for the five years 1908-12. Prices are subject to considerable variation, and this mixture might sometimes be made up at a much lower cost though perhaps occasionally dearer.

The reasons for recommending the foregoing mixture of seeds are:—

(1.) It is desirable to include in a mixture for a permanent pasture, all good plants that have any chance of success. Some may disappear, but if they survive all will be of use, especially in the second stage of the pasture's growth. Sainfoin and lucerne are only suitable for a southern climate, and they would not grow upon a stiff, undrained, clay soil; but if the subsoil contains an abundance of chalk, they may be recommended.

(2.) Both rye-grasses have been included, because they are quick-growing plants which cover the surface during the first two or three years. A covering is absolutely necessary on clay soils in dry districts, for if the sun gets at the soil, many of the less vigorous plants are destroyed before they have time to become established. The quantity of rye grass recommended is small, because thick seeding tends to choke out all other plants. Italian rye-grass is used mainly with a view to giving a fair bulk of produce in the first year; most of it will disappear after the first year, and will allow permanent plants room to develop.

(3.) The quantity of the larger permanent grasses is much less than is usually recommended. A careful examination of a number of recently sown pastures has shown that when rye-grass is included in the mixture it is unnecessary to sow much seed of the slower growing grasses.

(4.) Timothy and the two meadow-grasses have been used in greater quantity than other permanent grasses, because of their cheapness. When the price per million is considered, these grasses and white clover form the cheapest pasture plants. In moist seasons all four plants grow well, but in dry summers timothy and rough-stalked meadow grass are poor growers. In districts when the summer rainfall is low, the quantities of these two grasses recommended in the above mixture should be reduced by one-half.

(5.) Deep-rooted plants—burnet, chicory and yarrow—are useful in opening up the soil, admitting air,, and promoting a healthy development of the roots of other plants.

The principles kept in view in preparing the above list of seeds, were three in number. Firstly, the necessity of covering the soil quickly and uniformly. Secondly, the necessity of preserving a good "plant" of white clover, which, with the assistance of suitable manures, may be made to occupy a large portion of the soil during the second stage of the pasture's existence. Thirdly, the introduction into the pasture of a large number of good plants, some of them, like cocksfoot, timothy, and meadow fescue, especially useful in the second stage, and all more or less desirable in the mixed herbage of a permanent pasture.

The seeds-mixture is based upon the observation of the behaviour of pasture plants in a limited number of experiments in the Eastern Counties. It has not been tried and tested under different conditions, and its real purpose is to suggest a mixture for the use of those who are beginning the study of pasture plants and pastures. No great importance need be attached to the exact quantities of timothy, cocksfoot, &c., recommended. The quantities of rye-grass and clover specified are the smallest quantities that could be depended upon to produce a cover, but in the other cases, the object has been to introduce a sufficient stock of each of the plants into the pasture, and they are not meant to occupy much of the surface until the third or fourth year.

As the mixture is intended for use on poor clay soils, and as such soils are generally very deficient in phosphates, it will be desirable to use basic slag liberally on the young pasture. If the roots have not received a heavy dressing of basic slag or superphosphate, then from 7–10 cwt. of basic slag should be applied to the seeds in the autumn after the corn crop has been cut; but if the land has been manured immediately before sowing seeds, the application of basic slag to the young pasture may be delayed for a year.

Mixture for light and medium soils.—If a pasture on a clay soil is properly managed, white clover will cover the surface pretty uniformly about the third or fourth year after sowing, and it will often grow well on light loam soils in moist seasons; but under ordinary circumstances, white clover cannot be expected to cover nearly so large a proportion of the surface of light as of heavy soils. Chiefly for this reason, it is desirable to sow rather more grass on light soils than has been recommended in the above table, so that the place of clover may be taken by cocksfoot, the meadow grasses, hard fescue, and crested dogstail, during the second stage of the pasture's development.

For sowing down permanent pastures on light and

medium soils in a district having an average rainfall of 25–30 ins., the following mixture is suggested :—

—	Percentage Composition.	Per Acre. Approximate Number of Germinating Seeds in Thousands.	Approximate Weight.	Approximate Cost.*
Top Grasses—			lb.	*s. d.*
Perennial rye-grass	10·0	1,500	7	2 1
Cocksfoot	6·6	1,000	2½	2 6
Timothy	5·0	750	½	0 3½
Italian rye-grass	3·3	500	2	0 8
Meadow foxtail	1·6	250	½	0 8
Meadow fescue	1·6	250	1	1 3
Bottom Grasses—				
Hard fescue	10·0	1,500	2¾	1 10
Rough-stalked meadow grass	10·0	1,500	¾	1 1
Smooth-stalked meadow grass	10·0	1,500	1	1 4
Crested dogstail	3·3	500	½	0 9½
Golden oat grass	1·6	250	1/6	0 8½
Leguminous Plants—				
White clover	20·0	3,000	4¼	5 5
Alsyke clover	5·0	750	1	1 1
Perennial red clover	3·3	500	2¼	2 5
Lucerne	1·6	250	1¼	1 4½
Medick	1·6	250	¾	0 6
Miscellaneous Plants—				
Yarrow	3·3	500	1/6	0 9
Chicory	1·6	250	1	1 3
Total		15,000	29⅓	26 0

It is impossible to discuss here the variations that should be made in the above mixture in different districts, but it may be pointed out that rough-stalked meadow grass is a poor plant on a hot dry soil, and that lucerne, which is particularly useful under these conditions, is not adapted for northern pastures. In the south, on soils well supplied with lime, 5–10 lb. of unmilled common sainfoin may be included in the above mixture. Unmilled sainfoin often contains burnet as an impurity, and if burnet can be purchased cheaply in this way it may also be sown with advantage.

The mixture recommended for clay soils was made up in the usual way by taking a certain number of pounds of each seed ; in the foregoing table a second method of con-

* The footnote to page 4 applies equally here.

structing the mixture is shown. The approximate number of germinating seeds to be sown has been fixed upon, and the figures in the other columns have then been calculated.

The "pound" is altogether unsuitable when dealing with seeds. Not only does the number of seeds per pound vary widely, but the number of plants produced by a pound of different samples of the same seed is liable to great fluctuation. Farmers are therefore recommended to consider "number" and not "weight" when sowing, and to aim at a certain number of plants of rye-grass, &c., not at a certain number of pounds of seed. The seed merchant should be asked to guarantee the purity and germinating power of his seeds, and then the approximate number of plants that a pound will produce can be readily ascertained. It is not intended that the farmer should attempt by exact calculation and careful weighing to sow the precise numbers given in the above table. This would of course be impossible, and even if possible the attempt would be useless; for as has already been explained, soil, season, and manuring so affect the young pasture that it usually bears no close relationship to the particular mixture used in sowing, and a few thousands of seeds more or less will make but little difference. Why then, it may be asked, should one trouble about the percentage composition of the mixture? The reason for making some attempt at precision is this:—while soil and climate affect the character of the pasture produced by any particular seeds-mixture, the final result is in part due to the influence of one plant upon another. Rye-grass will affect cocksfoot, for example, and red clover will affect white clover. In order, therefore, that we may be able to explain the final results fully, we must know approximately the composition of the seeds-mixture, and a mere record of the number of pounds sown will not help us much because of the variation in the quality of seeds. One reason why agriculturists know so little about seeds-mixtures, is that they have no experience to guide them. Some mixtures have been sown and have given good results, other mixtures have been sown and have failed. When a permanent pasture does not answer expectations, four or five years after it has been sown down, it is rarely that the causes of failure can be traced. The careful seedsman who knows the exact composition of the seeds-mixture is unable to follow its history after it passes into the hands of the farmer; the farmer who knows all about the effects of season and manure, often pays no heed to the composition of the mixture, and thus he is no more able to explain success or failure than the seedsman. Until agriculturists give more attention to the compounding of the seeds-mixture than they now do, we shall be without that practical experience which is necessary to success in this, as in all departments of farming.

Six to nine months after sowing the seeds, light soils should receive from 3 to 5 cwt. of superphosphate, and from 2 to 4 cwt. of kainit per acre; and these manures, in quantities varying with the condition of the herbage, must be repeated at intervals of from two to three years until the pasture becomes established. Nitrogenous manures may also be employed with advantage under certain conditions, but to use them successfully on pastures, a farmer must be well acquainted with their properties, and their general use is not to be recommended. A dressing of from 7 to 10 tons of farmyard manure, two or three years after sowing down a pasture, would usually prove very beneficial.

Success in the formation of a pasture depends in no small degree on the treatment of the plants in the early years of their existence. After the covering crop has been harvested the young "seeds" should be rolled with a smooth roller as soon as the implement is likely to make any impression on the ground. This will effect consolidation and promote "tillering." Further, before being depastured the plants should be allowed to make considerable growth and establish a firm and fairly deep root-hold as a precaution against winter frost, spring drought, and the risk of being uprooted by stock. At the same time, if a short-lived plant such as red clover be allowed to reach or even approach maturity in the first autumn, the chances are that by spring much of it will have died. Grazing will check this, and, at the same time, encourage branching of the grasses. In spring the seeds should again be rolled to counteract the loosening effects of the winter's frost, and thereafter laid up for an early hay crop. Judicious grazing is not an inappropriate means of starting off a young pasture, but on the whole a hay crop cut when the earlier grasses begin to flower—thus obviating undue exhaustion of the plants by the process of seed formation and at the same time securing root development—is to be preferred.

In subsequent years the object must be the formation of a close even sole of herbage, a condition that implies uniform grazing and, if need be, the mowing of the rougher portions of the field which stock may refuse to eat.

Whitehall Place, London, S.W.1,
August, 1906.
Revised, May, 1912.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 169.

BOARD OF AGRICULTURE AND FISHERIES.

The Cultivation of Mangolds.

In Great Britain the mangold (*Beta vulgaris*) is chiefly cultivated in the southern and midland counties of England, since it requires a warm, somewhat dry, climate. The mangold grows best upon rich loams or upon such peaty soils as are found in the fens ; but in a suitable climate it is not very exacting as regards soil, and good crops may be grown upon light loams or upon stiff clays. In general it succeeds better upon stiff than upon light land. Under favourable conditions the mangold crop is one of the most valuable that a farmer can grow. As a food for dairy cows, for ewes after lambing, and even for pigs and poultry, mangolds are of great value, and, as they store well, they are admirably fitted for spring and early summer use. When they are pulped, mixed with chaff, and fed in conjunction with cake and meal an excellent winter ration for milk production is obtained. The amount fed may vary widely with the season of the year and with the quantity available. For dairy cows from 50-70 lb. per head per day is an ordinary allowance, while full-grown fattening cattle may receive from ¾ cwt. to 1 cwt.

The varieties commonly grown are the white-fleshed or Yellow mangolds, the yellow-fleshed, Golden or Orange mangolds, and the pink-fleshed, Red mangolds, all of these occurring in sub-varieties described according to shape, as Globe, Intermediate, Tankard and Long varieties. The mangold is essentially a food rich in sugar, nearly two-thirds of the total dry matter which averages about 12 per cent. consisting of that substance. The percentage of dry matter, however, varies considerably. Yellow Globe mangolds average about 10·5 per cent., while the Golden Globe, Golden Tankard and Long Red varieties may contain from 12·5 to 13 per cent. Small roots on the average are somewhat richer in dry matter than large ones. Certain changes take place in storing which render the roots more suitable as a food for stock, and they are therefore usually kept over winter until the early months of the year. They may, however, be fed to stock from October or November onwards—though not so suitable at this period—until the end of the following summer.

Preparing the Seed-bed.

As one of the root or fallow crops, mangolds follow a corn crop. They allow the ground to be thoroughly cultivated and cleaned, and as they are deep-rooting they materially assist

in getting the land into good "heart" for the succeeding corn crop. If the land is at all foul with weeds, autumn cultivation should be directed to cleaning, after which long manure should be carted on during dry weather and the land ploughed deeply for the winter. In some cases, however, the land is laid up in ridges for the winter with dung enclosed. If desired, dung may be applied in spring, but it should then be in the "short" or rotten condition. For seeding purposes a deep, mellow tilth is required, and to this end spring cultivation takes the form of ploughing, scuffling or cultivating, and harrowing, all perennial weeds being as far as possible removed. The aim should be to prepare a fine seed bed; but care must be taken not to over-dry the soil. If the soil is clean, it is desirable to prepare the ridges a fortnight or more before sowing the seed. When the land has been ridged in late autumn or winter the ridges are slightly harrowed down, at seed time or a little before, and artificial manure distributed. The ridges are then made up again with a ridging plough. If dung is to be applied in spring (1) the land may be ridged, and the dung spread, after which the ridges are split back, or (2) when sowing is to take place on the flat the dung may be ploughed in by the ordinary plough. Applications of dung in spring are, however, inadvisable in dry districts, and where mangolds are sown on the flat, it should be ploughed in during the previous autumn or winter.

Manuring.

Mangolds are much influenced in yield by the character of the manuring.

As in the case of most crops so in this: the manuring may be conducted along three main lines. The grower may depend on farmyard manure alone, or on artificials alone, or on a combination of both, according to the particular circumstances of the farm. If farmyard manure is abundant and of good quality, it may be most profitable to rely on it alone. On a farm where much straw is sold, or where the dung is chiefly used on the wheat or meadows, the mangold crop must be chiefly treated with artificials. But in the majority of cases the natural fertilizer is not so abundant, or of such high quality, as to be alone depended on, nor, on the other hand, is it so scarce as to be altogether ignored, and the result is that the mangold crop receives dung supplemented by artificials.

During the past fifteen years or so a large number of manurial experiments have been conducted on the manuring of this crop by agricultural colleges and societies, and although from the results thus obtained it is possible to draw conclusions which can be applied with confidence to average

conditions, every farmer should himself determine the manurial requirements of his land by means of some simple and well-conceived field experiments. (*See* Leaflet No. 80, *The Use of Artificial Manures.*)

The Use of Farmyard Manure Alone.—If land is in good "heart," and especially if it is the custom to top-dress the other crops in the rotation, it is often possible to grow a full crop of mangolds by using about 20 tons of dung without any addition of artificials. As a rule, however, it will pay better to use less dung for this crop, and to employ the surplus on some other crop of the farm, supplementing the dung by means of some artificial dressing.

The Use of Artificial Manure Alone.—Although large crops of mangolds can be grown without any farmyard manure, the use of artificials alone would be justifiable only under very exceptional circumstances. It might be warranted on outlying fields, or on farms favourably situated for the sale of straw, but in any case the crop succeeding the mangolds (unless it were barley) would seldom give a satisfactory yield without the direct use on it of a considerable amount of artificials. Speaking generally, if artificials are alone depended on for the mangolds they should be ample in amount and should contain all of the three important substances: nitrogen, phosphates, and potash. Of these, most attention should be given to the nitrogen, the bulk of which should be derived from nitrate of soda. This manure, in the great majority of cases, acts much better than sulphate of ammonia on mangolds. It is only in districts where the rainfall is heavy that the latter manure may replace the nitrate with advantage. Organic nitrogen, in the form of rape dust, blood meal, fish meal, dissolved bones, &c., often acts well in the absence of dung, and if these manures can be obtained at a reasonable price they may form a proportion of the mixture, especially on the lighter classes of soil. Without dung nitrate of soda may be used up to 3 cwt. per acre, though 2 cwt. will usually suffice, or half of this dressing may be replaced by a corresponding outlay on one or other or several of the manures just mentioned.

In the majority of cases superphosphate will furnish the most suitable form of phosphoric acid, 5 or 6 cwt. per acre being as much as will usually prove profitable. Basic slag does not generally prove a satisfactory substitute for superphosphate for use on this crop, at least when applied at the time of sowing the seed, though 3 or 4 cwt. per acre put on in early spring may, on heavy land, replace 2 or 3 cwt. of superphosphate. Dissolved bones, as has already been indicated, may to some extent be used, but bone meal is not to be recommended.

Potash has often proved to be the constituent that determines the success of this crop, and every farmer should take steps to ascertain its effect on his mangolds. Of the three forms generally available—kainit, sulphate of potash, and muriate or chloride of potash—the preference is generally to be given to the first on account of the common salt which it contains ; 5 cwt. per acre would be a suitable dressing in the absence of dung. Much has been written about the effects of common salt on the mangold crop, and there can be no doubt that in the absence of kainit its use, at the rate of 3 to 4 cwt. per acre, will often be found to pay, especially on the lighter classes of land.

The Use of Dung Supplemented by Artificials.—This is the usual and best combination in which to supply fertilizing materials to the mangold crop. The amount of dung which should be used per acre must depend chiefly on the aggregate amount at the farmer's disposal. Speaking generally, and having regard to practical convenience, 10 tons per acre may be taken as the minimum, while little is to be gained by exceeding 18 tons. Of the supplementary artificials nitrate of soda is by far the most important, and 1 to 1½ cwt. per acre may be put as the normal allowance. Phosphates are of less importance, and 2 to 4 cwt. per acre of superphosphate will usually suffice. Although dung holds much potash, the addition of this substance in the form of 2 or 3 cwt. of kainit will usually prove profitable, and it should not be omitted unless previous experience has shown it to be unnecessary. Here, as where artificials alone are used, salt may be given at the rate of 2 or 3 cwt. per acre.

In some parts of the country it is the custom to top-dress the mangold crop during June or July with ½ to 1½ cwt. per acre of nitrate of soda, and the practice may be recommended if the crop appears to require assistance. Where this course is followed some reduction should take place in the amount put on at the time of sowing the seed.

As regards the manuring of mangolds see also leaflet No. 80 (*The Use of Artificial Manures*); *and Special Report on the Manuring of Mangolds*, which can be obtained, post free, on application.

Seed and Sowing.

Mangold "seeds" as they occur in commerce consist of one to three true seeds embedded in a woody capsule, and this explains why several plants come up in a group, rendering careful thinning so necessary. The germinating capacity of mangold "seed" should be not less than 120, while it may be 180 or over.

Mangolds are usually sown between the beginning of April and the middle of May. Except in those districts which are exposed to late frosts, or in which mangolds are liable to "bolt," the earlier in April the sowing is done, the better are the prospects of the crop. Three to 6 or 10 pounds of "seed" are sown per acre, according to the method adopted, the quantity being least when dibbled. In most cases sowing on the ridge is to be recommended, but in dry districts or on light soils the "flat" system is preferable. Seed may be sown on the ridge by means of small drills covering two ridges at a time, with rollers before and behind the drill coulters, while on the flat an ordinary corn drill is employed. For small areas dibbling may be resorted to. The rows are usually from 26 ins. to 29 ins. apart when mangolds are sown upon the ridge, and from 22 ins. to 26 ins. apart when sown on the flat. It should be remembered that unnecessarily wide ridges mean a reduction in yield, and that the width should therefore be such as will just allow of after-cultivation being conveniently carried out. In dibbling, 1 ft. apart in the rows is about the distance for sowing, two or three "seeds" being placed in each hole. Mangold seed should not be sown deeper than ½ to 1 in. A roller should follow the drill when seed is drilled on the flat, and as a firm seed bed is necessary ridges should be rolled after sowing if the soil is at all loose or open.

Subsequent Treatment.

As soon as the young plants are well up the horse-hoe should be set to work, and all weeds kept down between the rows by repeating the hoeing until the widespreading leaves or the growth of the roots would render further treatment in this way harmful. Hand-hoeing also should be sufficiently frequent to keep down weeds between the plants in the rows. "Singling" commences as soon as the plants are well established, and usually from six weeks to two months after sowing. The plants are left 9 to 12 ins. apart, the lesser distance when the rows are over 2 ft. apart. Since several plants may grow from one "seed," some skill is necessary to carry out this operation in an efficient manner.

Top-dressing the crop once with nitrate of soda is frequently practised when the crop is about two months old (*see* p. 4), or two half-dressings may be given at a few weeks interval. A portion of the common salt may also be given as a top-dressing where this fertilizer is employed.

Pulling and Storing.

Pulling.—Harvesting of the mangold crop takes place during October or early November after yellowing of the

leaves. The quantity to be lifted may vary from 15 to 50 tons per acre; from 20 to 30 tons is an ordinary crop. Mangolds are pulled up by hand, the leaves are *twisted off* to minimise "bleeding," and the roots are then thrown into heaps and covered with the removed leaves.

Storing.—Being very liable to injury by frost, mangolds must be carefully covered. They may be stored in large quantities in pits or clamps. In the system usually adopted the roots are first arranged in a long triangular "clamp" about 6 ft. wide at the base. This "clamp" is then covered thinly with straw or bracken, which in turn is covered with 9 inches of soil dug from all round the clamp. The ridge layer of soil is best put on a week or so later in order to permit complete ventilation. Stored in such a manner mangolds will remain in excellent condition throughout the winter, during which time the roots will "ripen."

Whitehall Place, London, S.W.1,
March, 1907.
Revised, October, 1913.

Copies of this leaflet may be obtained, free of charge, and post free, on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

The Use of Lime in Agriculture.

The practice of liming or chalking the soil is one of the oldest and most widely-spread operations of British agriculture; unfortunately for many districts, it is a custom that is perhaps less observed at the present time than at any other period since farming became an organized industry. Until about forty years ago lime was much more extensively used in agricultural practice than it is to-day.

There are several reasons why the practice of liming has fallen so much into disuse. In the main, however, it may be said to be due to (1) increased cost of labour; (2) the increased use of artificial manures; and (3) the reduction in the value of corn crops. Several common manures contain lime, but a clear distinction must be drawn between free lime, as it exists in quicklime or slaked lime, and lime combined with an acid, as in bones, where it is combined with phosphoric acid, or in gypsum, where it is combined with sulphuric acid. What is necessary for the soil is not merely the chemical substance lime, but a base, *i.e.*, something capable of combining with the acids which are naturally or artificially produced in the soil. The desired base is found in quicklime or in slaked lime. Chalk and all natural limestones contain lime combined with carbonic acid, which, however, is so weak an acid that it is easily turned out and does not interfere with the basic properties of the lime, whereas in bones or gypsum the lime is already completely saturated with strong acids, and in superphosphate there is even an excess of acid, which demands more lime from the soil to neutralize it.

Quicklime and slaked lime when applied to the soil quickly revert to the state of carbonate of lime or chalk in which they existed before they were "burnt" in the kiln, and it is this substance, carbonate of lime, that is denoted in referring to "lime" in the soil. The superiority of burnt lime over chalk or limestone for application to the soil lies simply in the fact that it falls naturally into a fine state of division, some of it also passing into solution, so that it is more easily disseminated throughout the soil and acts with greater rapidity and in smaller quantities.

To return, however, to the point in question, only freshly burnt lime (quicklime), slaked lime, chalk, limestone, marl, basic superphosphate and basic slag contain "lime" in the farmer's sense, *i.e.*, in the form of a base capable of neutralizing acids; in bones, in superphosphate, and in gypsum the lime is combined with acids, and is no longer capable of acting as a base.

The Uses of Lime.

Besides its indirect value in neutralizing acids in the soil lime has several other uses, all of which are of great importance to the farmer. These uses may be given as follows :—

1.—Lime improves the nature of clay soil, making it more open and friable. Drainage goes on more readily, while the land is warmer, and is more easily worked to a good tilth. It is difficult to exaggerate the value of this action of lime on the heavier soils ; it is frequently possible to secure a seed bed when the unlimed land is still too wet to work, and the character of the crop may depend as much upon securing a good tilth as upon manuring.

2.—Lime is an essential plant food, and without it soils cannot produce good crops. Soils are generally considered to be deficient in lime when they contain less than from ·5 to 1 per cent. Some soils, however, which are provided with a considerable amount of organic matter, may respond to lime although they contain much more than these amounts.

3.—The insoluble reserves of nitrogenous and potassic material in the soil are brought into action and rendered available for the plant by the presence of lime. The following table shows the result of applying in January, 1903, 2,000 lb. per acre of ground quicklime to some of the grass plots at Rothamsted, where there was a good deal of residue from past manuring locked up in the soil :—

Year.	Plot 7. Yield with mineral manures only.		Plot 9. Yield with complete artificial manures.	
	Unlimed.	Limed.	Unlimed.	Limed.
	Cwt.	Cwt.	Cwt.	Cwt.
1903	49·5	51·9	50·1	60·5
1904	61·9	61·8	63·7	69·8
1905	44·3	47·2	36·9	52·2
1906	34·4	41·4	39·0	50·0

4.—The leguminous crops usually cultivated on the farm flourish better when a good supply of lime is present in the soil. Clover, in particular, is very intolerant of acid soil conditions, and is much more subject to clover sickness when lime is deficient.

5.—By maintaining a neutral re-action lime has a beneficial effect on the development of those bacteria which convert the organic compounds in the soil into soluble plant food. In the absence of lime, the decay of organic matter results in the formation of black acid bodies of a peaty nature unsuited to plant growth. The acidity thus produced checks the action of certain valuable groups of bacteria, such as the *Azotobacter*, which fix atmospheric nitrogen without the aid of leguminous plants, and the nitrifying bacteria which convert ammonia into nitrates.

6.—Lime in one form or another is the best remedy for finger-and-toe disease* in turnips and swedes. These root crops are always liable to the disease when the soil is deficient in lime.

The fertility of many farms to-day is undoubtedly due to the liming and chalking that was done by the farmers of the eighteenth and earlier centuries; they, indeed, made the soil, for it is through their labours that it remains in profitable cultivation at the present time. Owing to the very large amounts of chalk and lime which were then applied, it has been possible for later generations to live upon the capital thus accumulated and dispense with any expenditure of their own in this direction. But this spending process cannot continue indefinitely, for natural causes alone—*e.g.*, the percolation of rainwater—are steadily removing the lime in the surface soil; for example, the Rothamsted soil, which at the beginning of the nineteenth century must have contained something like a hundred tons of chalk per acre, has now less than fifty, and many other soils which started with a smaller initial stock are beginning to run dangerously short. In many parts of the country there is evidence that the land, especially on the heavier soils, is in need of liming, and though it might not be wise to return to the old heavy dressings of six to ten tons to the acre, a much smaller quantity, half a ton or so of ground lime per acre could be profitably applied at least once in the course of each rotation.

The Influence of Manures on Lime in the Soil.

The various classes of manures used in farming have some bearing upon the rate at which lime is washed out, and this question has been investigated at Rothamsted. The results of the investigations may be given briefly as follows :—

(1) Superphosphate, sulphate of potash, kainit, and kindred manures do not increase the loss to any appreciable extent.

(2) Farmyard manure and probably all organic manures diminish the loss of carbonate of lime.

(3) Nitrate of soda also diminishes the loss.

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* *See* Leaflet No. 77 (*Finger-and-Toe in Turnips*).

(4) Sulphate of ammonia increases the loss, removing about half its own weight of lime or nearly its own weight of chalk.

Lime sinks in the soil of grass land from purely mechanical *reasons; in* arable land this sinking is less marked, but *the lime is subject to a greater wastage by solution in the rain water percolating through the soil.*

The Classes of Lime.

In nature lime generally occurs as carbonate of lime, in the form of chalk, limestone, marble, marl, and other substances. Perhaps one-sixth part of the rocks composing the earth's crust consists of this material.

Those materials containing lime which are of any agricultural importance may be tabulated as follows :—

1. *Bases*, capable of neutralizing acids.
   - Quicklime, burnt lime, lime-shells, caustic lime=lime.
   - Slaked lime, calcium carbide residue = lime and water.
   - Chalk, limestone, marl, old mortar, waste from paper works, &c. = lime and carbonic acid.
   - Basic slag=lime and phosphoric acid (lime in excess).
   - Basic superphosphate = lime and phosphoric acid (lime in excess).
2. *Neutral salts*, in which the lime is already neutralized by a strong acid. Compounds of this class occur in :—
   - Gypsum = lime and sulphuric acid.
   - Bones and mineral phosphates = lime and phosphoric acid.
3. *Acid salts*, which contain more acid than the lime can neutralize. Compounds of this class occur in :—
   - Superphosphate / Dissolved bones } lime and phosphoric acid (phosphoric acid in excess).

Quicklime and Slaked Lime.—The most common form in which lime is purchased by farmers is that known as burnt lime, lime-shells, quicklime or caustic lime. It is obtained by burning either chalk or limestone in a lime-kiln. Quicklime greedily absorbs and combines with water, forming slaked lime, while it also readily takes up carbonic acid gas from the atmosphere, forming carbonate of lime which is similar in composition to pure chalk or limestone. For this reason quicklime should be exposed as little as possible to rain and to the atmosphere, but should be applied to the land without delay.

Where coal is cheap the price of good lime at the lime-kiln averages normally about 11*s*. per ton. A guarantee should be obtained that it contains not less than 85 per cent. of quicklime and not more than 4 per cent. of magnesia.

Ground Lime.—This consists of burnt lime (quicklime) which has been ground to a fine powder. It should be similar in quality to quicklime, but is often impure and contains less lime than ordinary quicklime.

Ground lime is more expensive than lime shells owing to the cost of grinding, which may amount in normal times to 6*s.* per ton, while an additional 3*s.* must be added for sacks. A good sample therefore may cost normally about 20*s.* a ton at the lime-kiln.

Ground Limestone.—This form of lime, which is now coming into more general use, consists of unburnt limestone ground to a fine powder. Compared with burnt lime its action in the destruction of vegetable matter in the soil is less rapid, and it is doubtful whether it will exercise the same influence in coagulating clay. On the other hand the general effect is similar to that of burnt lime, and it has a number of advantages. It is in a more convenient form to handle and to apply. It can be uniformly distributed in one operation, and there is no irritating effect upon the eyes and nose. Should unsuitable weather occur it can be held over until better conditions prevail, and, if necessary, it may be stored for use the following season without fear of deterioration or destruction of bags.

Roughly speaking, 1¾ tons of ground limestone are required to supply the same amount of lime as 1 ton of burnt lime, but even allowing for the extra quantity required, it may be cheaper to apply the former. Ground limestone should contain at least 40 per cent. of fine powder capable of passing through a sieve having 10,000 apertures to the square inch and should also give on analysis about 95 per cent. of carbonate of lime. Good quality ground limestone may cost normally from 11*s.* to 12*s.* per ton, in bags, free on rail.

Chalk.—This substance is really a soft limestone, and when the flints are removed is usually a very pure form of carbonate of lime. When fairly pure it will contain about half its weight of lime. When treated with a 1 per cent. solution of citric acid (which is approximately equal to the acid in soil water) the lime in chalk is about half as soluble as the lime in caustic lime. The application of large quantities of chalk (from 8 to 20 tons or more per acre) to agricultural land was formerly a general practice in some parts of the country. In recent years, however, this method of applying lime has been largely discontinued, but it is still common in some districts, especially in the southern counties. The chalk is dug out of the pits in late autumn and spread over the land before it becomes dry. No attempt is made to break up the lumps, as the winter frosts and a harrowing in the spring will reduce them to a sufficiently fine state of division.

Marls.—These are mixtures of earthy matter and carbonate of lime, but their consideration is beyond the scope of this leaflet.

Gypsum.—This compound of sulphuric acid and lime is seldom employed as a separate manure, but it forms about two-fifths of the weight of ordinary superphosphate.

Gas Lime.—This form of lime is a by-product in the manufacture of coal gas, for which lime is employed as a purifying agent. It consists of slaked lime more or less saturated with compounds of sulphur; it is liable to considerable variation in composition, and often has but little basic property left in it and so cannot take the place of lime or chalk. It contains small proportions of certain compounds of sulphur which are virulent plant poisons; on exposure to air and rain, however, and especially when mixed with earthy material such as roadside parings, the cleanings of ditches, ponds and the like, absorption of oxygen takes place and the injurious constituents (sulphites, sulphides, &c.) are converted into useful manurial substances. It is unprofitable to use it at considerable distances from a town, or where high railway rates prevail, as the percentage of lime present is usually small.

Basic Slag.—Basic slag is a by-product in the manufacture of steel, and is very largely employed as a phosphatic manure. It usually contains about 45 per cent. of lime, and a considerable proportion of this is available as a base capable of neutralizing acids in the soil, though probably not more than 2 to 5 per cent. is in the form of "free" or "caustic" lime. The fact that the lime present is available for counteracting acidity in the soil renders basic slag of very considerable value on soils deficient in lime. For further information as to the use of basic slag reference should be made to Leaflet No. 267.

Other Sources of Lime.—In addition to the better known forms of lime already referred to, lime may be obtained as a by-product in manufacturing processes such as paper making and the manufacture of acetylene from calcium carbide.

Large quantities of carbonate of lime in a very fine state of division are produced from causticising plant in paper works. In the past, the value of this by-product as a source of agricultural lime has not been fully recognised and the lime has usually been allowed to go to waste. Where it has been used, however, it has been found fully as effective as other forms of lime, and might well be tried for agricultural purposes more extensively than it is, especially if arrangements can be made for drying it at the works. After it has been dried it may contain from 60 to 80 per cent. or more of carbonate of lime. It should be applied at about the same rate as ground limestone.

Lime is also obtained as a by-product in the manufacture of acetylene gas from calcium carbide. In this case the by-product is chiefly in the form of slaked lime containing from 30 to 40 per cent. of water; when dried it usually contains 60 per cent. or more of quicklime. This form of lime, however, must be used with caution. Fresh samples frequently contain impurities likely to be poisonous to plant life and in no case should the residue be applied before these impurities have been rendered innocuous by exposure to the weather. After weathering, the lime may be safely applied as a substitute for quicklime. It is best applied to fallow ground during the winter; trials on a small scale should be made before any growing crop is dressed with the residue.

Among other kinds of waste lime which may be used, when available, are "small" lime or screenings, the residues when lime shells are sold, and small chalk which is sometimes obtainable at a comparatively cheap rate from manufacturers of lime.

None of the miscellaneous forms of lime mentioned should be bought except after analysis.

The Application of Lime.

Slaked Lime.—The most common method of liming is to put quicklime (lime shells) on the land in small heaps and allow it to slake naturally, or to slake it with water from a water-cart. It may then be spread with a shovel and harrowed in at once. There are certain objections to the first method. Too much moisture is apt to be absorbed by part of the heap, with the result that the lime becomes pasty and, afterwards, through the absorption of carbon dioxide, reverts into hard lumps of carbonate of lime. It is usually preferable to deposit the lime for slaking in one large heap near a supply of water, and cover it with a few inches of soil to exclude air. When it is convenient to apply the lime the heap should be opened out and slaked. After standing about twelve hours the lime should be passed through a riddle and all lumps separated should be watered again. If properly slaked the lime will have fallen to a fine dry powder which should be at once distributed over the field either by machine or by shovel from the cart. It is desirable, especially when small quantities are being applied, to adopt the American plan, *i.e.*, to use a suitable manure distributor, to which old sacking has been attached at the sides and behind. This trails along the ground, insures better distribution, and prevents much of the discomfort that is otherwise caused by the blowing about of the fine lime. Glasses for the eyes and protective devices for the nostrils and mouth are also used by men who do this work.

Since lime is used for many purposes the proper quantity to apply varies widely. Common dressings are from 2 to 3 tons of quicklime at intervals of from six to ten years Smaller dressings of about 10 cwt. to 1 ton per acre once in four or five years are now becoming common. Considerably larger quantities than the above may be used in the treatment of newly-reclaimed land rich in organic matter and plant food.

Ground Lime.—This is usually applied by means of a manure distributor at the rate of from 5 to 30 cwt. per acre.

Ground Limestone.—This form of lime should be applied at the rate of about 1¾ tons in place of every ton of burnt lime.

In regard to the time of application, lime, in the forms mentioned above, may be spread on the stubbles in autumn prior to preparing the land for roots. The subsequent working of the land aids distribution: on stiff clays in particular, this method is best calculated to improve the physical condition of the soil. It is important, however, that the land should be ploughed immediately after the lime is spread. In other circumstances lime is best applied after ploughing, either prior to or immediately following the sowing cf corn, and is lightly harrowed in. It is commonly applied in spring after roots and prior to taking corn with "seeds."

Gas Lime.—Owing to the presence of certain poisonous compounds already mentioned, gas lime should be evenly spread on the land six or eight weeks before ploughing. It is best applied to lea in the autumn or early winter, at the rate of from 2 to 4 tons per acre. On most soils the oat crop which follows will be considerably benefited. A compost of gas lime and earthy material should be allowed to stand for some months before application, the heap being turned two or three times at intervals as found convenient.

Chalk.—The amount of chalk applied may vary from 8 to 30 tons per acre according to the requirements of the soil. On stiff clay soils even larger quantities are sometimes applied. It is best put on in late autumn.

Whitehall Place, London, S.W.1,
April, 1907.
Revised, April, 1916.

Leaflet No. 171.

BOARD OF AGRICULTURE AND FISHERIES.

Rhizoctonia Diseases.

A disease due to the fungus *Rhizoctonia violacea*, Tul. was recognised and described nearly two hundred years ago as the cause of serious injury to the saffron industry in France. It was at that time also noted that the disease attacked the roots of many other kinds of plants, both wild and cultivated. From this period it has not only continued its ravages, but has attacked in turn almost every new plant introduced to cultivation. It does not, however, attack cereals.

Plants Attacked.

In this country *Rhizoctonia* has a special predilection for lucerne; clover, parsnips, carrots, beet, mangold, seakale, and potatoes sometimes also suffer severely, and most frequently when they follow lucerne, which appears to attract the stray mycelium of the fungus present in the soil. The mycelium increases enormously in quantity on the root of this plant, and a large stock remains in the soil in a vigorous condition ready to attack any suitable host. If the following crop happens to be a cereal, which the fungus cannot feed upon, it attacks weeds of various kinds, and thus tides over the period until a crop suitable to its requirements is planted, when a fresh stock of mycelium is again left in the soil.

Description and Appearance of Plants Infested.

The disease is readily recognised by the bright colour of the mycelium of the fungus, which varies from rose, with a tinge of purple, to a deep brownish purple when old. The mycelium at first spreads as a delicate, much-branched network over the surface of the root or tuber, and finally forms dense patches, or covers the entire surface with a compact felt (see fig. 1). As a rule the fungus confines its attacks to underground parts of the plant, but when the weather is continuously damp and dull the mycelium sometimes extends up the stem, and even passes on to the leaves and fruit.

The first sign of disease is the drooping and yellowing of the foliage; the presence of violet mycelium on the surface of a carefully removed root proves the fact.

Sources of Infection.

So far as is at present known, the fungus does not form fruit, its only mode of reproduction being vegetative by means of mycelium.

The way in which the fungus spreads in the soil and keeps its hold can readily be seen. When a root or tuber has become superficially coated with a felt of mycelium, sclerotia or concentrated masses of mycelium of two distinct kinds of structure, and having different uses, are formed. Some sclerotia are of considerable size, varying from that of a pea to a hazel nut; these become free from the root when fully formed, and remain in the soil as centres of future infection. Other sclerotia, rarely exceeding the size of an ordinary pin's head, are usually produced in considerable numbers under the felt of mycelium, and in close contact with the root or tuber, to which they remain firmly attached, and are removed along with it. If such infected roots or tubers are eaten by some animal, the minute, compact sclerotia are not injured by passing through the digestive system, and are in this way often transported to new localities. In like manner new districts are often infected by means of minute sclerotia attached to potato tubers, carrots, &c. In some instances beans and peas are attacked while yet in the pod, and minute sclerotia are formed in the skin of the seed.

The disease usually spreads from a point of infection equally on every side, the mycelium gradually spreading through the soil from diseased to healthy plants.

Injury Caused by the Disease.

The amount of injury caused by the fungus varies to a great extent on different plants. In the case of *beet* and *carrots*, the mycelium soon enters the fleshy root and destroys it. In *lucerne* and *clover* the active rootlets are killed. In *potatoes*, mycelial strands originating from the small sclerotia described above penetrate the skin, and ramify abundantly in the internal tissues, causing a rot which soon reduces the tuber to a pulp.

Preventive and Remedial Measures.

1.—Good drainage and the prevention of sourness of the soil are essential features in combating the disease. Liming is of value in preventing acidity of the soil.

2.—Weeds should be rigorously suppressed, for they furnish the main supply of food for the fungus when a cereal crop is present.

3.—Care must be taken not to introduce the disease by means of small sclerotia adhering to seeds or tubers.

DESCRIPTION OF FIGURES.

FIG. 1.—*Rhizoctonia violacea.*—The illustration shows the brownish purple mycelium, which occurs in patches and radiating strands over the surface of the tubers. Mycelium also enters the flesh, and destroys the tissues.

FIG. 2.—*Rhizoctonia solani.*—The sclerotia, which in this species are entirely superficial and apparently cause little or no injury, are seen as conspicuous blackish bodies. They can be scraped off the tuber without difficulty.

FIG. 3.—Later stage of *R. solani.*

4.—Seed obtained from dry, high-lying districts should be selected.

5.—Diseased plants should be removed and burned, and the soil treated with a disinfectant before being re-planted. In the case of seakale, the best results have been obtained by treating the soil some days before planting with a solution of carbolic acid (1 oz. to a gallon of water). The seakale not only came up free from disease, but actually appeared to be stimulated in growth. Good results have also been obtained by the use of corrosive sublimate solution (1 oz. to every 8 gallons of water).

6.—Before planting, seed potatoes should be steeped for 2 hours in a solution, consisting of 1 pint of commercial formalin (= 40 per cent. formaldehyde) in 36 gallons of water.

Potatoes are also attacked by another species of *Rhizoctonia*, *R. solani*, Kühn. The tubers are found covered with small black bodies, or sclerotia, of irregular shape, connected only by fine threads of mycelium which are not visible to the naked eye (see figs. 2 & 3). These bodies can be easily scraped off, leaving very little scar, and do not appear to cause much injury beyond rendering the tubers unsightly. In America, however, it seems that the fungus may cause serious losses by attacking the young sprouts.

R. solani has been stated to be the underground, sterile state of the Potato Collar fungus, *Hypochnus solani*, Prill et Del. The latter forms a very thin, greyish, or fawn coloured film round the base of living potato haulms, but the mycelium is entirely superficial, and does not appear in this country to cause any injury.

The treatment recommended for *R. violacea* is applicable also to this disease.

Whitehall Place, London, S.W.1,
May, 1906.
Rewritten, August, 1913.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

BOARD OF AGRICULTURE AND FISHERIES.

Bare Fallows.

Historical.

The practice of taking a bare fallow as a preparation for wheat was at one time almost a universal custom in farming. It was said to have been introduced into these islands by the Romans, and in mediæval times the usual rotation appears to have consisted of wheat, barley, fallow, with beans instead of barley on the stronger lands. In Scotland, where up to the eighteenth century it was the custom to grow corn crops repeatedly and then let the land lie in grass for a few years, the introduction of a bare summer's fallow, after the ley was broken up and before the wheat was sown, was one of the earliest improvements in the traditional system of farming. The thorough cleaning which the land received, and the marked improvement in the tilth which was effected, were strong arguments in favour of the practice; furthermore, experience amply demonstrated that better crops of wheat could be secured after a bare fallow than after a previous corn crop or a recently ploughed lea. The early theorists concluded that some fertilizing principles were absorbed from the atmosphere during the summer's exposure to sun and air, and, indeed, it became patent that the more thoroughly the soil was stirred and pulverized by the cultivations the greater was the benefit resulting from the fallow.

But towards the close of the eighteenth century the custom had begun to decline; green crops, and turnips in particular, had become part of the routine of farming, and the Norfolk husbandry, with its four-course system of turnips, barley, clover, wheat, was spreading from the Eastern Counties all over Great Britain.

The more advanced farmers perceived the importance of keeping the land under crop; by growing turnips it was possible to obtain all the advantages, in the shape of the cultivation and the stirring of the soil, which result from a bare fallow; at the same time, food was provided for the stock, and a much better kind of dung was made than when the straw was merely trampled down to get it into a state fit to go back upon the land. The writings of Arthur Young,

who was Secretary to the then Board of Agriculture, in the early years of the nineteenth century, were unceasingly directed against bare fallows; and his influence, combined with the numerous enclosures and the high prices prevailing during the Napoleonic wars, did much for the spread of turnip culture. The strong lands and the clays were still the difficulty; on them it was often a costly and even an impossible operation to secure a good plant of turnips, but it became more and more a mark of careless farming to rest content with a bare fallow. Mecchi showed that the strongest Essex clays could be made to grow turnips, and with the spread of mangel cultivation it became possible to put even the most stubborn soils in the South and East of England under roots. The bare fallow still survived as an occasional operation once in seven or eight years, and many clay-land farmers maintained that it was a profitable operation, the benefit of which was felt for several years. Latterly, with the fall in corn prices and diminished rents, the acreage under bare fallow has again showed a tendency to increase. For instance, in Essex the bare fallow in 1866 amounted to 11·4 per cent. of the land under corn; in 1904 it was 16 per cent.; in Suffolk the bare fallow has actually increased, despite the diminution in the area of arable land, rising from 25,000 acres in 1866 to 30,400 acres in 1904.

Beneficial Effects of Bare Fallows.

A bare fallow may exert a beneficial effect on the land in three ways:—

1.—*By cleaning the land of weeds;*

2.—*By improving the texture of the soil; and*

3.—*By increasing its fertility.*

1.—A bare fallow is generally taken after a stubble crop the prime object being to get as many weed seeds as possible to germinate. A first ploughing in autumn will be followed by a cross-ploughing in the spring and two other ploughings in the summer. Sometimes the first ploughing is left until the spring corn has been sown, and is followed by two or even four ploughings during the summer. The harrow is used after each ploughing to collect the weeds, and many farmers roll the land to reduce the clods and promote the germination of the weeds. But on many soils it is desirable to avoid getting too fine a tilth, lest heavy rains cause the land to run together and the surface to set to a hard crust, To this danger the heavy loams and clays with an admixture of fine sand are more liable than the clays proper.

The continued cultivations and repeated draggings will rid the land of couch; at the same time annual weeds are germinated, and destroyed by the next ploughing.

2.—It may be said, however, that with reasonable farming land should never get so foul as to require a bare fallow to clean it, and it is found among the clay-land farmers that their chief justification for a bare fallow lies in the great improvement in the texture of the soil that results. A clay soil is in the main composed of very fine particles, and the finer the particles are the "heavier" and the more tenacious is the clay. Coarse-grained material like sand does not bind together when dry, but the more fine-grained it becomes the more sticky will it be when wet, and the firmer will it set when dry. To a certain extent these very fine particles in an ordinary clay soil are loosely bound together into little groups which behave like single larger particles. If, however, the clay is knocked about when it is wet the groups are broken up into their constituent fine particles, thus increasing both its holding power for water and its tendency to dry to a hard clod. This is seen to the fullest extent when clay is deliberately "puddled," in which state the particles making up the clay are all separate and able to move independently. Exposure to the weather, on the contrary, freezings and thawings, alternate dryings and wettings, unite the particles again and lighten the texture of the soil. With the best of management the texture of heavy clay land tends to deteriorate under cultivation, and the rest it gets by lying under grass for a year or two, or from a summer's fallow, is necessary from time to time to get the soil back into a good working condition. The improvement persists for three or four years and forms the main reason for taking a bare fallow nowadays; for good crops, particularly of roots, depend more on the tilth of the seed-bed than on any other single factor in farming.

3.—Many have been the theories as to whether land gains or loses fertility through a summer's fallow. Thaer, who was an authority about the beginning of the eighteenth century, wrote: "There is no doubt that the fallow absorbs or attracts the fertilizing properties of the atmosphere." Arthur Young, on the contrary, with his aversion to bare fallows, wrote about the same time: "The quantity of gas or vapour that is hourly exhaling from a fallow field after rain or every fresh ploughing is improvidently lost, and argues a want of economy that is truly reprehensible." But experience was against Arthur Young; the practical farmer knew that cultivation by itself made the land better able to support a crop; this was the basis of Jethro Tull's horse-hoeing husbandry and of the Lois-Weedon system of alternate husbandry. Anybody, again, who visits an experimental farm, where the plots are separated by paths, will recognise the "fallow effect" in the increased vigour of the outside rows bordering the bare soil. An explanation, however, was not possible until the discovery of nitrification some twenty years ago and the investigations which have been made into the conditions favouring the process.

All soils contain considerable residues of nitrogenous material which cannot reach the plant until they have been oxidized by various bacteria in the soil and so converted into nitrates. A summer's fallow provides just the conditions favourable to nitrification—warmth, aeration, the stirring of the soil, and the greater amount of moisture which results from the absence of a crop to dry the soil.

Gain of water by fallowing.—It is easy to ascertain that the fallowing results in a great gain of water to the soil; for example, at Rothamsted in 1904, halves of certain plots were fallowed while the other halves carried wheat. The soil was sampled in mid-September, after harvest, with the following results:—

—	Percentage of water in fine soil.	
	Cropped.	Fallow.
1st depth of nine inches	17·4	17·2
2nd " "	18·8	20·0
3rd " "	20·1	22·3
4th " "	20·9	23·1

or down to the depth of 3 ft. an average gain of 1·35 per cent. of water, equivalent to 3·1 in. of rain. In a climate like that of Great Britain this extra water is a matter of little or no moment, since the land becomes saturated repeatedly by the winter rainfall, but in more arid countries it often makes all the difference to the crop. In parts of California, for example, it is only possible to take a crop like wheat every other year without irrigation, the bare fallow in the intermediate years being necessary to collect the rain for a full yield.

Accumulation of nitrates.—The chief gain, however, from a summer fallow lies in the way the nitrates are made and stored up in the soil for the benefit of the ensuing crop. The Rothamsted experiments illustrate the increase thus produced, for there one plot grows wheat every year without manure, and the second is divided into two portions, one of which is fallowed while the other is cropped every alternate year. The yield is as follows:—

—	Wheat every year.		Wheat after fallow.	
	Grain.	Straw.	Grain.	Straw.
	Bushels.	Cwt.	Bushels.	Cwt.
Average crop per acre per annum, 1856–1902 ...	12·7	10·0	17·1	14·2

This shows a considerable gain for fallowing, but it must be remembered that the land in the second case is only cropped every other year, hence the production per acre under cultivation is only half as much, or 8½ bushels per acre per annum.

The benefit of fallowing depends upon the formation of nitrates during the summer and their retention for the next crop, but heavy rain during the winter may wash them entirely away and leave the land no richer. This is plainly seen if the results given above are divided into two groups according as the autumnal rainfall, September to December inclusive, is above or below the average :—

—	16 Seasons of less than average rainfall.	16 Seasons of more than average rainfall.
Rainfall (Sept.—Dec.)	8·88 in.	13·66 in.
Percolation through 60 in. soil ...	4·03 in.	8·92 in.
Total produce (wheat after wheat)...	1,810 lb.	1,627 lb.
Total produce (wheat after fallow)...	2,743 lb.	1,757 lb.
Percentage increase due to fallow ...	51·5	7·9

Thus when followed by a dry autumn, the fallowing produces an increase of more than 50 per cent. in the ensuing crop, whereas if the winter be wet the increase due to fallowing is little or nothing.

It therefore follows that summer fallowing is only likely to be of direct benefit to the next crop where the climate is dry and no great amount of percolation takes place through the soil in the winter. It is, on the whole, more likely to result in a permanent loss of fertility, and can only be justified on those heavy soils which need an occasional rest to maintain their condition and restore a good tilth.

Clover Crop v. *Bare Fallow*.—Another of the Rothamsted experiments illustrates how much may be gained by a clover crop in place of a bare fallow. One of the fields is farmed under a four-course rotation—swedes, barley, clover or fallow, wheat ; one half of the plots growing clover and the other fallowed before the wheat. The better the clover the better the ensuing wheat, and if we compare the succeeding crops after a good clover year its benefits are very marked :—

—	Clover Hay.	Wheat.	Swedes.	Barley.
	Cwt.	Bushels.	Tons.	Bushels.
Clover plot	76·7	39·5	19·4	36·3
Fallow plot	—	32·5	19·0	28·3

Although nearly four tons of clover hay were removed, the residues, roots and stubble, were sufficient to increase the wheat crop by 21 per cent.; the root crop, which came next, by 2 per cent., although the same manure was put on both crops; and finally the barley, three years after, by 28 per cent.

Conclusion.

From all these results it will be seen that a bare fallow can never be a directly profitable operation and has no justification on free-working land. But with strong clays in dry climates, as for example over much of the East and South-East of England, it may often be necessary to clean the land and restore its friable texture; on such soils also there is least likelihood of loss through the washing out of the reserves of nitrogen which have been rendered available by the process. Bare fallowing may in such a case be useful.

Whitehall Place, London, S.W.1,
May, 1906.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 173.

BOARD OF AGRICULTURE AND FISHERIES.

Potato Growing.*

Potatoes are grown successfully on many kinds of soil, but a sand of good "body" or a medium porous loam is best adapted for the crop. Fen lands are also very suitable. There is no fixed rule as to the position potatoes should occupy in the rotation, but in most cases they follow a corn crop. "Seeds" or old grass also form good preparatory crops. The decaying vegetable matter furnished by the sod is valuable not only as a source of food for the plant, but also on account of its beneficial influence on the physical condition of the soil.

The habits of the plant demand a good tilth. The land should therefore be ploughed deeply in autumn and cross-ploughed, if possible, in early spring. In ploughing old grass a skim coulter should be used so as effectually to bury the turf; or the turf may be heavily cross-disced or lightly cross-cultivated and cut into small pieces before being ploughed under. Subsequent operations should be directed to securing as much cover for the sets as possible without bringing turf to the surface. In some cases it may be found best to plough lightly a second time and plant the sets in the bottom of say every third furrow.

Seed.

Small compared with Large Seed.—The success or failure of the crop largely depends on the character of the seed tubers. In many parts of the country it is the practice to plant small tubers, the bigger ones being sold for cooking purposes. There is considerable diversity of opinion as to the best size of seed to plant; some growers prefer large seed, whilst others believe that equally good results will be obtained from small. In discussing their cropping capabilities, two kinds of small potatoes must be considered: (1) the late-formed tubers of strong, robust plants, and (2) the produce of plants of low vitality. If the bulk of the seed consists of the former, then quite satisfactory returns may be obtained, as the tubers are small simply on account of their having had insufficient time to reach full size; if the seed, however, be the small, stunted produce of weakling plants, only weakling tubers can be expected from them, practically all

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* Further information on potato growing will be found in Leaflet No. 296 (*Potato Growing in Allotments and Small Gardens*); Special Leaflet No. 68 (*Hints on Purchasing Seed Potatoes*); and Special Leaflet No. 69 (*Cultivation of Early Potatoes under Glass*).

of which will fall into the seed class. Whilst it may be possible, therefore, to obtain a good crop the first year from small seed, owing to the likelihood of the seed consisting largely of tubers formed late in the season, the chances are that if seed from the same stock be used for a number of years in succession, an ever-increasing proportion will be the produce of weakling tubers, with the result that the returns will become more and more unsatisfactory.

Experiments have shown that tubers about the size of a hen's egg generally prove the most profitable for planting purposes, but when supplies of seed are scarce and dear there need usually be no hesitation in planting somewhat smaller tubers provided they are the produce of a uniformly vigorous crop, or have been grown in a cool, northern climate.

Whole compared with Cut Seed.—Should the supply of whole seed run short, it is unwise to make good the deficiency by cutting seed-size tubers. No serious reduction in yield, however, need in general be feared from the use of sets obtained by cutting large tubers of the round or pebble type. With this class of cut sets the weight planted per acre may be considerably greater than when seed-size potatoes are planted whole, but, on the other hand, the produce will generally contain a less proportion of "small" tubers than the produce of whole seed. Planting should be done directly after cutting, and the sets covered in with as little delay as possible. Exposure even during the dinner hour may be sufficient materially to reduce the yield from cut sets.

N.B.—In view of the short crop in Scotland in 1916 it may not be possible, this year, for English growers to obtain their usual consignment of northern grown seed. Furthermore, there is reason to believe that "once grown" seed (*i.e.* the first produce of Scotch seed planted outside of Scotland) is relatively scarce. In these circumstances growers would be well advised to cut for seed, when available, the "ware" of Scotch crops, or box the ware of once or even twice grown stocks and, at planting time, cut for sets only those tubers showing strong, vigorous sprouts.

Liming the Cut Surface.—When, however, it is necessary to prepare seed a day or two in advance of planting, the tubers, as soon as cut, should be dipped in finely-powdered lime. The effect of the lime is to form a "scab" over the wet surface of the set, which prevents, or, at any rate, considerably retards, evaporation of moisture.

Change of Seed.—Vigour and disease-resistance are affected by the age of the variety. New varieties are generally more vigorous; the longer vegetative reproduction is carried on the weaker a plant becomes. Further, too much stress can hardly be laid on the importance of change

of seed. New seed is unquestionably more disease-resisting than seed that has been grown on the same farm for a number of years, and to secure the biggest crops, apart altogether from the question of disease, it would seem to be necessary to introduce new seed every year, or at least every second year. At Garforth, in 1903, *new* seed of four well-known varieties, viz., British Queen, Challenge, Conquest, and Eightyfold, produced, on the average, better crops by 3 tons 9 cwt. per acre than seed from stock which had been grown *four* times without change. Moreover, the crops from the new seed were not diseased, whereas on the average 22 per cent. of the crops from the older seed were diseased. In both cases the seed was procured from Scotland.

The advantage of using new seed was also strikingly shown in experiments carried out at Cambridge in 1905. In this case Scotch seed of four varieties, viz., Up-to-Date, British Queen, Northern Star, and Factor, was compared with seed of the same varieties grown locally for three and, in the case of Up-to-Date, five years in succession. On the average the increased yield in favour of the crops grown from the Scotch seed was 9 tons 10 cwt. per acre.

In the southern counties it is always advisable to change seed after the second year, and, in some localities, every year, especially after a hot, dry summer. The Garforth experiments showed also that as far north as Yorkshire it may be profitable to change the seed after the *second* year. Crops of British Queen and Conquest, grown for three years in succession on the farm, produced, on the average, 2 tons 1 cwt. *less* than crops of the same varieties grown only two years, and included many more diseased tubers.

Results since obtained at various stations in England furnish additional evidence with regard to the benefits to be derived from frequent changes of seed.

It may be pointed out that new seed should be obtained as early in spring as possible, before sprouting has commenced, so that the damage which sprouted potatoes suffer in course of bagging and transit may be avoided.

Scotch and Irish Seed.—That Scotland and Ireland afford a good change of seed for England has long been known, but why this should be so is not quite clear. A number of influences are probably at work. It seems probable that the increased vigour of potato sets from Scotland and the North of Ireland is due not only to a difference in soil and latitude, but to the extra moisture available during the period of growth and to reduced sunshine during the time of ripening, coupled also with a greater freedom from disease. One important characteristic of Scotch seed is that in spring it is slower in sprouting than English seed and therefore runs less risk of damage in handling.

During the past few years experiment has shown that *seed tubers from Ireland are about equal in cropping power when grown in England to those sent south from Scotland. Two experiments at Cambridge, one in 1908 and the other in 1910,* tend to prove that seed from the west, north-west, and south-west parts of Ireland is distinctly better and produces heavier crops than seed obtained from the east side of that country. (The export of potatoes from Ireland is at present prohibited except under license from the Department of Agriculture and Technical Instruction for Ireland.)

A potato grower in the east of England may reasonably expect an increased yield of potatoes of from 2–3 tons per acre if he changes his seed every two years, and he will be equally safe in purchasing his stocks either from Ireland or Scotland, provided he uses his judgment in making inquiries beforehand.

Further, there is ample evidence to show that seed grown at a high altitude is well adapted for growth in lowland districts. Farmers in hilly districts should bear this in mind with a view to establishing a seed trade with growers on lower ground.

Immature Seed.—The results of numerous experiments confirm the belief of many potato growers that tubers lifted in an immature or unripe condition give better yields than tubers of the same varieties which have been left in the ground until their full development has been attained. This is, doubtless, partly due to the fact that by lifting the crop before growth has been completed a large proportion of seed-size tubers, derived mainly from the most productive plants, is retained for seed purposes. It has further been observed that immature seed, grown locally, produces an earlier crop than mature seed grown under the same conditions. "Blight," in consequence, does less damage to the crop, for growth is more advanced at the time of the year when the plants are attacked by the disease. A further advantage is that by lifting early the vitality of the tubers is not affected by the disease causing "leaf-curl."

There is no difficulty in storing immature seed. Small quantities may be clamped in the usual way, but, as a rule, it is desirable to leave them on the ground to become thoroughly green and store them when dry.

Storing of Seed.

During recent years different methods of storing seed have been tested, and the practicability of growing in the later districts considerably larger crops than formerly has been clearly demonstrated.

***Boxing in Autumn.*—According to this method, which has been largely adopted for some years by the growers of**

early potatoes, seed-size tubers are placed in the autumn in shallow boxes containing no soil or other material, and stored throughout the winter in tiers in a cool, well-ventilated and well-lighted shed. No artificial heat need be used. From time to time the order of the boxes in the tiers should be reversed so as to ensure an equal amount of light to all the potatoes. This treatment leads to the "greening" of the tubers and the development of short, sturdy green sprouts, which do not break off during planting, and the crop gets an "early start." Further, experiments conducted at Kew showed that "greened" tubers lose only about one-sixth as much in weight during the season as those not "greened," and are therefore firmer; while "greening" will to a great extent check the ravages of winter rot. The method, however, involves a good deal of labour at a time when work presses, and, further, accommodation for boxes is often lacking on farms at this season of the year. In the southern and eastern districts no great advantage is usually to be gained by sprouting the seed of late varieties, provided clamped seed is planted before sprouting commences.

Boxing in Winter or Early Spring.—This method permits of tubers being "pied" straightway in autumn and transferred to boxes in winter or early spring, whenever weather conditions are suitable and men can be spared for the work The question of accommodation and protection from frost is not so serious in spring.

In some cases quite as good crops have been grown from seed stored in this way as in the former, but in general it is less satisfactory to box in winter and early spring than in the autumn.

A very convenient box is that illustrated on p. 6. From 100 to 120 of these will be required per acre, and the cost, normally, may vary from 30*s*. to 40*s*. per acre, the boxes, however, lasting several years.

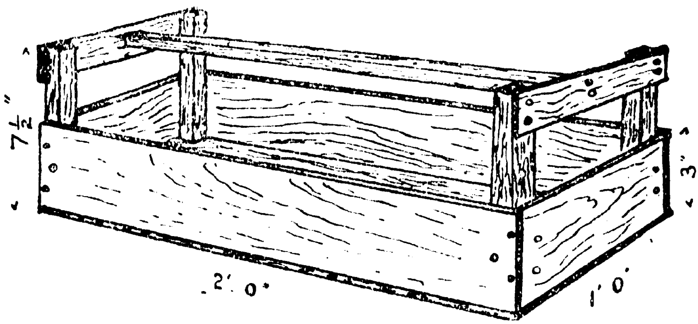
Pieing in Autumn and Planting direct from the Pie.—Both of the methods just described have proved superior to the ordinary one of planting direct from the pie. All three were first compared at Garforth in 1903. For the test in that year the variety planted was Up-to-Date, and an advantage of two tons per acre followed the use of boxed seed. In 1904, five varieties (second early and late) showed an advantage of 33 cwt. per acre in favour of boxed seed. In 1905, an average increase of one ton per acre was produced at Garforth by seven varieties when boxed seed was used.

In each year these results were obtained from Scotch seed, introduced into Yorkshire in the previous season, and, as

might have been expected, excellent crops were obtained without any special treatment. Even with such seed, however, boxing resulted in a profitable increase.

It must, however, be stated that in each of the trials the potatoes were planted in May. Further experiments appear to show that as great advantages are not obtainable in districts where planting is possible about the beginning of April.

Where large areas of potatoes are planted it is difficult to provide sufficient boxes for the seed, or accommodation for



Box for sprouting seed potatoes.

the boxes, but it should at least be possible to box the earlier varieties. If it be found impracticable or unnecessary to box the seed of late or maincrop varieties, which do not sprout in the pies to the same extent as the early varieties, it is perhaps better to spread the seed some time in early spring in a thin layer on the floor of a dry, well-lighted shed, than to leave it in the pie till planting time.

The free admission of light is important. It has the effect of producing a slow, sturdy growth of sprouts which are much less liable to be knocked off at planting time than the pale, elongated sprouts produced in the dark.

In addition to minimizing the damage to sprouts, early removal of the seed from pies is beneficial for another reason. Rotting frequently takes place in the pie, sometimes to a serious extent, and sprouts which have come into contact with rotten tubers are often considerably damaged, and not infrequently killed. Rotting may be checked by dusting the tubers freely with quicklime before pieing. Lime, used in the "quick" form readily becomes detached from the tubers in spring, leaving them clean and dry. Slaked lime should not be used, as it adheres to the tubers in a pasty condition, and on drying becomes firmly attached to them. Sprinkling the tubers with powdered sulphur at the rate of 2 lb. per ton of tubers also holds winter rot in check.*

* See also Leaflet No. 193, *Winter Rot of Potatoes.*

Choice of Variety.

Success or failure in potato growing is determined largely by the choice of variety. The seed may be in first-class condition, the soil and manures may be the same for all, and yet one variety may yield tons per acre less than another. In testing varieties of potatoes it is especially important that the stock from which the seed for the test is drawn should have been grown under the same soil and climatic conditions.

The value of a variety should not be gauged solely by its cropping capacity. *Cooking quality* is a very important point, which is, however, largely dependent on soil and season. Good cooking tubers should not lose colour on boiling, but should remain creamy white; they should be mealy, with a glistening fracture; and they should remain white on cooling. *Disease-resisting power* is a most important consideration, and so also is the natural tendency of the variety to form tubers the bulk of which are big enough to be put upon the market as ware. Choice of variety, also, must be governed by the *demand of the market*. There are many good coloured varieties, but the demand for such in city markets is comparatively limited, and it certainly pays best to grow only those that will meet a ready sale. Out of a large number of varieties tested during the last few years, the following may be taken as best fulfilling general conditions* :—

First Earlies.—Duke of York, Ninetyfold, Sharpe's Express, **Epicure**, and May Queen.

Second Earlies.—**Eclipse**, British Queen, King George V., Royal Kidney, **Great Scot**, and **King Edward VII.**

Late or Maincrop Varieties.—Up-to-Date, or varieties of a similar type, such as Dalhousie, Duchess of Cornwall, Factor, Table Talk, Dalmeny Beauty, and Dalmeny Regent; Langworthy, Golden Wonder, Evergood, **Arran Chief**, and Northern Star.

WART DISEASE.

Where Wart Disease has occurred, only those varieties proved experimentally to be resistant to the disease should be planted and a licence from the Board must be obtained.

In trials recently conducted at Ormskirk on land badly infected with Wart Disease, Epicure, Scottish Standard, King Edward, Arran Chief, Up-to-Date, and Ajax produced, on the average, 1 ton 16 cwt. of sound tubers and 4 tons 6 cwt. of warted tubers per acre, while King George, Great Scot, Culdees Castle, Golden Wonder, and Kerr's Pink produced 11 tons 11 cwt. per acre of sound tubers and no warted tubers.

* The varieties indicated by the heavier type are, generally speaking, the most reliable.

It is evident, therefore, that when immune varieties are planted, excellent crops of sound tubers can be obtained from badly infected land, but that only disaster can result from planting varieties susceptible to this disease.

*Manuring of Potatoes.**

Probably no crop grown on the farm receives more manure than the potato crop. Though, in most cases, the plant responds readily to liberal manuring, it is doubtful if it is a greedier feeder than other "fallow" crops. It should be borne in mind that the largest possible crop is not always the most profitable, and that an excess of manurial ingredients over the requirements of the crop may lead to considerable waste. It may be argued that any such excess will benefit future crops, but the farmer wants the highest possible return on the first crop—"residual value" being frequently a more or less doubtful asset.

Dung alone.—In manuring potatoes a certain amount of dung is always beneficial. It may be applied at different periods of the year. In the drier districts autumn or winter applications are to be preferred; elsewhere spring applications generally give the best results. A dressing of 20 tons of dung per acre is not uncommon, and with this alone good crops may often be obtained. It frequently happens, however, that the foliage is encouraged at the expense of the tubers, especially when artificials are also applied, and actually heavier and more profitable crops can be grown by using half the above quantity of dung with artificials. If the land is in very poor condition, 20 tons of dung may prove more profitable than 10, but in many cases the former quantity is too large to be applied with profit.

Dung Supplemented with Artificials.—The most common system of manuring potatoes is to apply a moderate dressing of dung—say about 10 tons per acre—and supplement it with artificials. In this case caution is necessary; artificials are probably too frequently applied in excess of the requirements of the crop, smaller profits being consequently obtained than when smaller quantities are applied.

When crops of from 9 to 10 tons per acre can be grown solely by the aid of moderate dressings of dung there is a risk that any increase in yield obtained by the additional use of artificials may be produced at too great a cost.

The following mixture of artificials per acre may be recommended as a safe and reliable one under most circumstances, and no farmer should use artificials in greater quantity along with 10 tons of dung until he has thoroughly

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* Further information regarding the manuring of potatoes will be found in Leaflet No. 80 (*The Use of Artificial Manures*).

satisfied himself by experiment that it can be done with profit :—

1 cwt. sulphate of ammonia.
2 to 3 cwt. superphosphate.
1 cwt. sulphate of potash (when available)*.

This mixture will contain 4 to 5 per cent. of nitrogen (equal to 5 to 6 per cent. of ammonia), 13 to 15·6 per cent. of soluble phosphates and 10 to 12·5 per cent. of potash.

Under present conditions from 1 to 1½ cwt. of sulphate of ammonia and 3 to 4 cwt. of superphosphate may be used in place of the normal dressing stated above. If the full allowance of superphosphate is not obtainable a smaller quantity should be supplemented with steamed bone flour or ground mineral phosphate ; or 4 to 5 cwt. per acre of a high "soluble" slag may constitute the sole phosphatic dressing.

In the case of early potatoes with a comparatively short period of growth 1½ cwt. of sulphate of ammonia may be given in addition to the phosphatic manure mentioned above.

The Effect of Artificials when no Dung is Applied.—**Though dung is generally regarded as essential in the manuring of potatoes, very good and highly profitable crops can be grown without it.**

The following mixture of artificials per acre may generally be depended upon to produce as big a crop of potatoes as 10 tons of dung :—

2 cwt. sulphate of ammonia.
5 cwt. superphosphate.
2 cwt. sulphate of potash (when available).*

The mixture will contain 4·4 per cent. of nitrogen (equal to 5·3 per cent. of ammonia), 14·4 per cent. of soluble phosphates, and 11·1 per cent. of potash.

As before, if the full allowance of superphosphate cannot be given, as much as possible of this manure should be used, and the deficiency made up with either steamed bone flour or ground mineral phosphate ; or 6 cwt. of high "soluble" basic slag may be the sole phosphatic dressing. (Sulphate of ammonia should not be mixed with basic slag or mineral phosphate.)

Dung, when readily obtainable, will doubtless prove more economical than the above mixture of artificials, but there are times—*e.g.*, after grass—when such a mixture alone will give quite as profitable returns as 10 tons of dung.

*** For the present potash is scarce and very expensive, and the quantities indicated should only be used (even if available) in cases in which the grower has proved that full supplies of potash are essential for his crop. In other cases half the quantity should be used.**

Sulphate of Ammonia v. *Nitrate of Soda.*—When used with dung there is generally little to choose between these two sources of nitrogen in regard to the yield of the crop, but when no dung is used the results are mostly in favour of sulphate of ammonia. It is possible that in the absence of direct supplies of potash nitrate of soda may give the better results.

Calcium Cyanamide and Nitrate of Lime.—Experiment has shown that in some cases these fertilizers are about equal in value, nitrogen for nitrogen, to sulphate of ammonia.

Different Potash Manures.—Sulphate of potash will, in most cases, give the best results, but there is so little to choose between the sulphate and the muriate that a farmer should be guided by their respective unit prices at the time of purchasing.

Both these forms have proved superior to kainit. There is an idea prevalent amongst farmers that kainit, owing to its attractive power for moisture, is superior to the other forms on sandy or light soils, especially in a dry season. This, however, does not appear to have been borne out by experiment.

In view of the small stocks of these manures at present available in this country the supplies of potash required will have to be obtained as far as possible from other sources. On rich loams, on the heavier classes of soils generally, and in the fens, potash manures will not be greatly needed if an average dressing of farmyard manure or (in certain districts close to the sea) seaweed can be applied. One ton of farmyard manure or 12 to 13 cwt. of seaweed contains on an average about as much potash as 1 cwt. of kainit. Even when supplies of farmyard manure are available, however, the lighter classes of soils would probably be greatly benefited by a small quantity of potash in the form of artificial manure. For these soils recourse may be had to compound manures containing potash, where such are obtainable, care being taken to select those with a composition most nearly approaching that of the normal standard mixtures given above. Potash may also be purchased in the form of Peruvian guano, many samples of which contain from 2 to 3 per cent. Assuming a sample to contain 8 to 9 per cent. of nitrogen, 25 to 30 per cent. of phosphates and 3 per cent. of potash, 4 cwt. per acre would give approximately the same amount of potash as 1 cwt. of kainit and, where dung is applied, an ample amount of nitrogen and phosphates.

Rape meal.—As a manure for potatoes, rape meal is held in high favour in districts where the soils are light in character. It contains about 5 per cent. of nitrogen and 4 per cent. of phosphates, and, like most organic manures, decomposes slowly in the soil. A mixture consisting of 2 cwt. rape meal, ½ cwt. sulphate of ammonia, and 1 cwt. sulphate of potash,

with 10 tons of dung per acre, has given very satisfactory results on light soils in Yorkshire.

The Effect of Manures upon Cooking Quality and Disease.

Cooking Quality.—The quality of the potato is dependent upon many factors, including soil, season, variety, the state of ripeness of the tuber, and the system of manuring. The application of a heavy dressing of dung appears to depreciate somewhat seriously the value of a potato for cooking purposes. A moderate dressing is considerably less harmful, whilst the addition of a well-balanced mixture of artificials to a moderate dressing of dung will, other things being equal, produce potatoes of the first quality. In its effect on the quality of the produce, sulphate of ammonia is preferable to nitrate of soda when used in conjunction with dung, but when no dung is applied nitrate of soda, as an ingredient of a mixture of artificials, may be quite as satisfactory as sulphate of ammonia. On soils requiring large quantities of potash, sulphate of potash should be employed in preference to either muriate of potash or kainit.

Disease.—Manures which tend unduly to stimulate the growth of the foliage, such as heavy applications of dung or mixtures of artificials containing a rather high percentage of nitrogen, render the plants more liable to disease.

Planting.

Time of Planting.—Potatoes should be planted in spring, as soon as a good tilth can be obtained. April is generally a suitable month, but planting is sometimes possible towards the end of March, while good returns are not infrequently obtained from seed planted in May. When, however, no special precautions—such as boxing—are taken to preserve the first sprouts, it is advisable to plant the potatoes so that they shall, as far as possible, make their first growth in the soil. A good covering of soil will protect the sets from frost, even when planted as early as the end of March, but as soon as the weather becomes fairly mild, part of the covering should be removed by harrowing, as weak and spindling sprouts result if they have to push their way through a considerable thickness of soil before reaching the light.

Depth of Planting.—As to the proper depth to plant, a great deal depends upon the character of the soil. Where the soil is loose and friable it is possibly advantageous to plant fairly deeply. When dung is applied in the row the danger of the sets being covered too much is minimized, but when potatoes are planted without dung in the row there is considerable risk of their being covered too deeply, especially on the heavier class of soils.

Distance Apart.—The width between the rows, and the distance between the sets in the rows also depend upon the

local conditions, but in general 26 inches between the rows and 15 inches between the sets will prove satisfactory. On the other hand, on some soils and in some localities 12 inches between the sets has yielded a better crop.

In the case of First Early varieties the distance between the rows may be 20 to 24 inches, and between the sets in the row, 8 inches.

Time to Lift Potatoes.

It is highly important that potatoes should be lifted as soon as they are ripe. It has been demonstrated repeatedly that comparatively healthy crops can be obtained even from those varieties which are generally regarded as being very liable to disease if attention is given to this point.

Formation of the Pie.

The general principles on which a pie or clamp is made are practically the same throughout the country. The method of covering the pie, however, varies considerably, but the following may be safely recommended. The usual roof-shaped pie is covered with a layer of straw about 6 in. thick. A plank about 1 ft. broad and from 8 to 10 ft. long is then placed along the top or ridge of the pie, and the sides to the edges of the plank are covered with an inch or two of soil. The plank is then moved along and another length is covered with soil. In this way the top of the pie is kept free from soil, thus providing for ventilation. It may be necessary to add more soil to the sides later in the year, but the top is left untouched except, perhaps, in a time of severe frost, when a covering of potato haulm is put over the straw. Potato haulm should not be used for this purpose, however, unless the crop from which it was derived was quite free from disease.

Diseases of the Potato.

The potato crop is subject to several fungus diseases which may cause serious loss both in yield and quality of the produce. A number of these diseases are dealt with in certain of the Board's Leaflets, as follows:—No. 23 (*Potato Disease*); No. 105 (*Wart Disease of Potatoes*); No. 117 (*Black Leg or Potato Stem Rot*); No. 137 (*Varieties of Scab in Potatoes*); No. 164 (*Potato Leaf Curl*); No. 171 (*Rhizoctonia Diseases*); No. 193 (*Winter Rot of Potatoes*); No. 242 (*Bacteriosis of the Potato and Tomato*).

Whitehall Place, London, S.W.1,
October, 1906.
Revised, January, 1917.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 174.

BOARD OF AGRICULTURE AND FISHERIES.

Tree Root-rot (*Armillaria mellea*, Vahl.).

This destructive parasite, also known as Collar Rot and *Agaricus melleus*, is one of the most abundant and widely distributed of British "toadstools." In addition to attacking nearly all kinds of orchard and other broad-leaved trees, it is parasitic upon European and some introduced conifers.

Description.

The fungus, in common with many other kinds, grows in dense clusters round the roots of living trees, also round dead stumps. In some instances it appears to grow directly from the ground, but careful examination in such cases shows that the mycelium springs from buried wood, roots, &c. It is distinguished by the dingy honey-yellow coloured cap being covered, more especially towards the centre, with small, darker scales; the stem is coloured like the cap and has a frill or ring near the top; when young this frill extends from the stem to the edge of the cap and conceals the gills, which are whitish. Myriads of spores are produced, which form a snow-white powder on whatever they fall. These spores are distributed by wind, game, mice, &c., and aid greatly, but not solely, in spreading the disease.

Indications of Disease.

Usually the first indication of disease is the drooping and yellowing of the foliage. When this symptom manifests itself, the presence of a thin, firm, white sheet of mycelium, situated between the bark and the wood at the collar, or on the main root-branches, clearly indicates *A. mellea* as the cause of the mischief. This felted white mycelium often extends up the trunk between the bark and the wood for several feet, and changes gradually into blackish cord-like strands of mycelium, called rhizomorphs, which continue to grow upwards between the wood and the bark as the latter becomes dry and separates from the wood. These cord-like rhizomorphs become variously branched, and anastomose to form an irregular black network, so frequently met with on removing the bark from a dead trunk, indicating the cause of its death. Black rhizomorphs may also be found surrounding the root-branches. In fact, these first infect the tree by penetrating the bark of the root and giving origin to the white mycelium.

Prevention and Remedy.

1.—When the leaves of a tree droop and turn yellow owing to the presence of the fungus, curative measures are hopeless, as the mycelium has by this time completely girdled the trunk. Nevertheless, it is very important at

this period to adopt measures against an extension of the disease. When a tree has been killed the black rhizomorphs surrounding its root extend in all directions about three or

I.—Cluster of Armillaria mellea. II.—Rhizomorph on Root.

four inches below the surface of the ground in search of living roots of a fresh tree. When such are encountered, the tips of the rhizomorphs pierce the bark and give origin to

the white mycelium, which eventually kills the tree. These underground rhizomorphs travel for an unlimited distance in the ground, and, unless checked, constitute a continual source of danger to trees surrounding the one attacked.

When a tree is attacked a portion of the bark at the collar should be removed, and if the white mycelium is found to have passed up the trunk the case is hopeless, and the wisest course is to cut down the tree, and remove as much as possible of the root, which should be burned. The roots should not be used for ornamenting, as when this is done, dense masses of toadstools appear in due course, and the underground rhizomorphs spread on every side.

2.—If the mycelium has not entered the trunk, but is confined to certain branches of the root, these should be removed, and as much as possible of the root exposed, and covered with a mixture of equal quantities of quicklime and powdered sulphur. This mixture should also be placed round the base of the trunk before the soil is filled in.

3.—Whether a diseased tree has been removed, or treated in the hope of recovery, a trench about eight inches deep and six inches wide should be made all round the site of the tree, at a distance well outside the spread of the branches. The object of the trench is to intercept the spreading rhizomorphs. If in a situation where an open trench can be allowed to remain, this is all that is required to be done. If the position is such that an open trench would be objectionable, planks about six inches deep, well coated with gas-tar, may be let into the ground instead, and will answer the same purpose. In making the trench it is important that the soil removed be spread over the ground enclosed by the trench.

4.—When the toadstools appear at the base of a trunk, they should be collected and buried ; crushing them underfoot is worse than useless, as this only aids in the dispersal of the spores.

5.—Great care should be taken not to injure the base of the trunk or exposed roots, as the spores can only enter the tree through a wound. The grass-mower is responsible for many wounds, through which this and various other fungi parasitic on trees first gain an entrance.

Whitehall Place, London, S.W.1,
July, 1906.

Copies of this leaflet may be obtained free of charge and post free on application to the Secretary, Board of Agriculture and Fisheries, 3, St. James's Square, London, S.W.1. Letters of application so addressed need not be stamped.

Leaflet No. 175.

BOARD OF AGRICULTURE AND FISHERIES.

The Use of Waste Organic Substances as Manures.*

There are several ways in which a manure may be beneficial, but in general most manures serve one or more of four purposes, which are :—

1.—*To increase the supply of available plant food either directly, or indirectly through its solvent action on the soil.*

2.—*To improve the mechanical condition of the soil.*

3.—*To hold up water in the soil and so ensure a constant supply to the plant.*

4.—*To favour the growth and work of micro-organisms on whose activity the productiveness of the soil to a certain extent depends.*

Value of Organic Manures.

Mineral substances, with the exception of lime and basic slag, chiefly serve one function only,—they supply plant food; but organic substances, like dung and the products described below, act beneficially in all the directions already enumerated. They furnish plant food, although the proportions are not well balanced, and somewhere in the rotation the proper mineral substances must be added if the best results are to be obtained. They have a marked effect on the mechanical condition of the soil: a heavy soil is lightened by their mere presence and also as a result of their decay; and a light soil is improved by the cementing action of the humus to which they give rise. Without organic matter it is difficult to secure a good tilth.

One of the most valuable properties of organic manures, and one in which they far surpass artificials, is their power of holding water. The water supply in many soils is insufficient for securing maximum crops; the manuring and cultivation adopted would give much better results if more water were present, provided, of course, it had no depressing effect on the soil temperature and air supply. This question will probably assume even greater importance as the necessities of the towns compel them to sink more and deeper wells in the country. Already in

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* Other Leaflets dealing with Manuring of Farm and Garden Crops are No. 72 (*Purchase of Artificial Manures*); No. 80 (*Use of Artificial Manures*); No. 93 (*Farmyard Manure*); No. 106 (*Fertilizers for Market Garden Crops*); No. 170 (*The Use of Lime in Agriculture*); and No. 254 (*Use of Seaweed as Manure*).

many districts the water level appears to be lower than it was; shallow wells are in consequence left dry and have to be deepened, and the supply available for the fields promises to be still further curtailed. Proper cultivation and the application of organic manures are two good ways of conserving the water supply.

Organic matter is not indispensable; crops can be grown on an experimental scale without it. But the advantages due to its presence are well recognised, and it should be replaced as it disappears from the soil in consequence of bacterial and other actions. The farmer uses dung, and the manure manufacturer frequently puts organic matter into his compound fertilizers.

There are a number of waste products, used at present only in special branches of farming, some of which deserve a more extensive trial, particularly by market gardeners, who are finding it increasingly difficult to obtain adequate supplies of dung at a moderate price. This leaflet deals with certain substances used in the hop gardens of Kent and Surrey, but there is no fundamental reason why their use should be restricted solely to hops, and some of them have been applied with great advantage to other crops. Nor is their use confined to a particular type of soil; they are generally applied to light chalky or sandy land, but this is by no means essential.

There are, however, certain drawbacks with regard to purchasing. The supply is somewhat irregular, and bulks are often not uniform; it is difficult to draw a representative sample for analysis, and dealers often decline to give any guarantee as to composition. Competition from other quarters may force prices up too high, while difficulties attendant on sanitary regulations may have a similar effect, or they may act in precisely the opposite direction. There is no uniformity of price; indeed, prices vary in neighbouring districts in an apparently haphazard way. Little information is obtainable as to the relative manurial value of the various substances; the usual pot experiments are not quite satisfactory, because sufficient account can hardly be taken of the power to hold up water. It seems certain, however, that, provided the mechanical condition is satisfactory, these substances have more value than is commonly believed.

The prices quoted in this leaflet are those which the practical hop grower who is in a position to make favourable purchases finds it worth his while to pay.

The substances dealt with fall into three groups:—

1.—*Residues from animal carcases*: Dried blood, feathers, greaves, hair waste, hoofs and horns, rabbit waste, slaughter-house refuse.

2.—*Residues from manufactures*: Damaged cakes, shoddies, tannery waste.

3.—*Residues from towns*: Destructor refuse, night-soil poudrette, sewage sludge.

4.—*Seaweed and vegetable refuse.*

1.—*Residues from Animal Carcases.*

Dried Blood.—This is an excellent fertilizer, and it is used by some manufacturers for their mixed manures. The price at which it is offered to farmers appears usually to be too high, in consequence, it is understood, of competition from America and the Continent. Usually about 12·3 per cent. of nitrogen is guaranteed, and prices in January, 1915, varied from £10 10*s*. to £11 per ton, or 17*s*. to 18*s*. per unit.

Feathers and Feather Waste.—Excellent results are obtained in some hop gardens by using about 20 to 25 cwt. of feathers, and the limited supply (amounting probably to only a few hundred tons a year) is rather keenly sought after. Large feathers are slow in action, the shafts especially taking a long time to decay; a sample containing many of them is not as valuable as one composed mainly of small, more easily decomposable feathers. The nitrogen obtained is usually a little over 8·24 per cent., and a not uncommon price is £6 10*s*. to £7 per ton delivered, giving a unit price of about 16*s*. to 17*s*. In spite of the generally good mechanical condition, this price is, perhaps, too high. The price naturally fluctuates; as much as £8 per ton has recently been given, but it is doubtful whether this high price could be justified.

Greaves.—This is the refuse or sediment left in making tallow or soap grease. Clean samples, derived from butchers' fat and the trimmings of joints, are used as food for dogs, pheasants, and poultry; lower grades, obtained in melting down grease from other sources, are available as manure, and have been effectively used on hops, fruit, wheat and other crops. The composition varies, and the fluctuation in price is considerable, 70*s*. to £12 being perhaps the outside figures, but it is not difficult to fix a maximum value for a particular sample, because of the close relationship between greaves and meat guano. The latter article consists of well-dried and finely ground greaves mixed with bone meal; as a manure it is superior to ordinary roughly ground greaves, and a higher price may reasonably be paid for the nitrogen it yields. At present meat guano is being offered in Kent and Surrey at 14*s*. 6*d*. to 17*s*. per unit for nitrogen and 1*s*. 3*d*. to 1*s*. 9*d*. per unit for phosphate; it should be used in preference to greaves unless there is a distinct difference in price. The prices asked for greaves are sometimes excessive; a sample yielding 4·12 per cent. of nitrogen and 5 per cent. of phosphate, and worth at the time from 50*s*. to 55*s*., was

offered to the Wye College at £5. No doubt the varied uses of greaves as food, for meat guano, and as an ingredient of certain mixed manures accounted in some measure for the high price asked.

Hair (*Calf Hair, Hair Waste*).—This yields about 9·9 per cent. of nitrogen, but it does not easily decompose in the soil. As a rule the mechanical condition is very bad; the hair is matted in lumps which resist all ordinary farm appliances and absolutely refuse to break down. They may be in the soil for an indefinite time without perceptibly diminishing. Calf hair has been known to remain for two years in a hop garden and at the end of that time still yield 9·9 per cent. of nitrogen when brought to the laboratory.

Having regard to its unsatisfactory mechanical condition, hair must be valued at less than feathers and much less than meat guano. Perhaps 4*s*. 10*d*. to 6*s*. per unit of nitrogen is fully as much as it is worth; this would make its value about 50*s*. to 60*s*. per ton. At the same time, if it could be supplied in a finely divided state it would be more valuable; even as at present supplied a higher price is often paid for it.

Hoofs and Horns.—The value of these is regulated mainly by their fineness; high grade samples of horn shavings and finely-ground horns yielding 12·3 to 14 per cent. of nitrogen are largely used by market gardeners. Other grades yield about 9·9 per cent. of nitrogen, and 20 to 25 per cent. of phosphate. They contain some bone. The demand has gone up enormously during the last few years and the unit price of the nitrogen is about 18*s*. to £1 in the highest grade samples. On the other hand, *whole* hoofs and horns and materials like trotter scutch (consisting of hair, hoof, and bone), sometimes bought by farmers, are of little value until they have been finely ground.

Rabbit Flick (*Rabbit Waste*).—This consists of the ears, feet, tail, and various other external portions of rabbits. The mechanical condition is usually very fair, but if the substance could be broken up a little more its value would be increased. It yields from 9·9 to 12·3 per cent. of nitrogen, and sells at about £6 10*s*. per ton; the unit value of the nitrogen therefore averages 11*s*. 6*d*. A certain amount of phosphate is invariably present. Rabbit waste is regarded by many practical men as quite a useful fertilizer, the only drawback being that the supply is rather restricted.

Slaughter-House Refuse, Viscera, &c.—The proper way to utilize slaughter-house refuse is to convert it into meat meal or guano, in which form it can easily be carried about without interference from sanitary authorities. Where those who contract to clean out cattle markets have the refuse removed in barges it finds its way to waterside farms. It is worth about the same price as town stable manure.